

POPULAR SCIENCE

MONTHLY



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Fisher Body has produced its share of this armament — tanks, anti-aircraft guns, gun-breech housings, fighting planes, bombers and delicate flying instruments.

To do this we had to disregard the normal limits of our business, and build products entirely new to us. We had to explore technical fields foreign to us. We had to enlarge our plant facilities.

Looking back on those hectic days and nights of conversion, we realize that an understanding of true craftsmanship proved

to be, literally, a lifesaver. Precision work on armament came easily to precision workmen. Long-acquired skills and crafts met demands for the most extreme accuracy.

And an important reason why Fisher Body has yet to fail at a war job is because craftsmanship has never yet failed us.

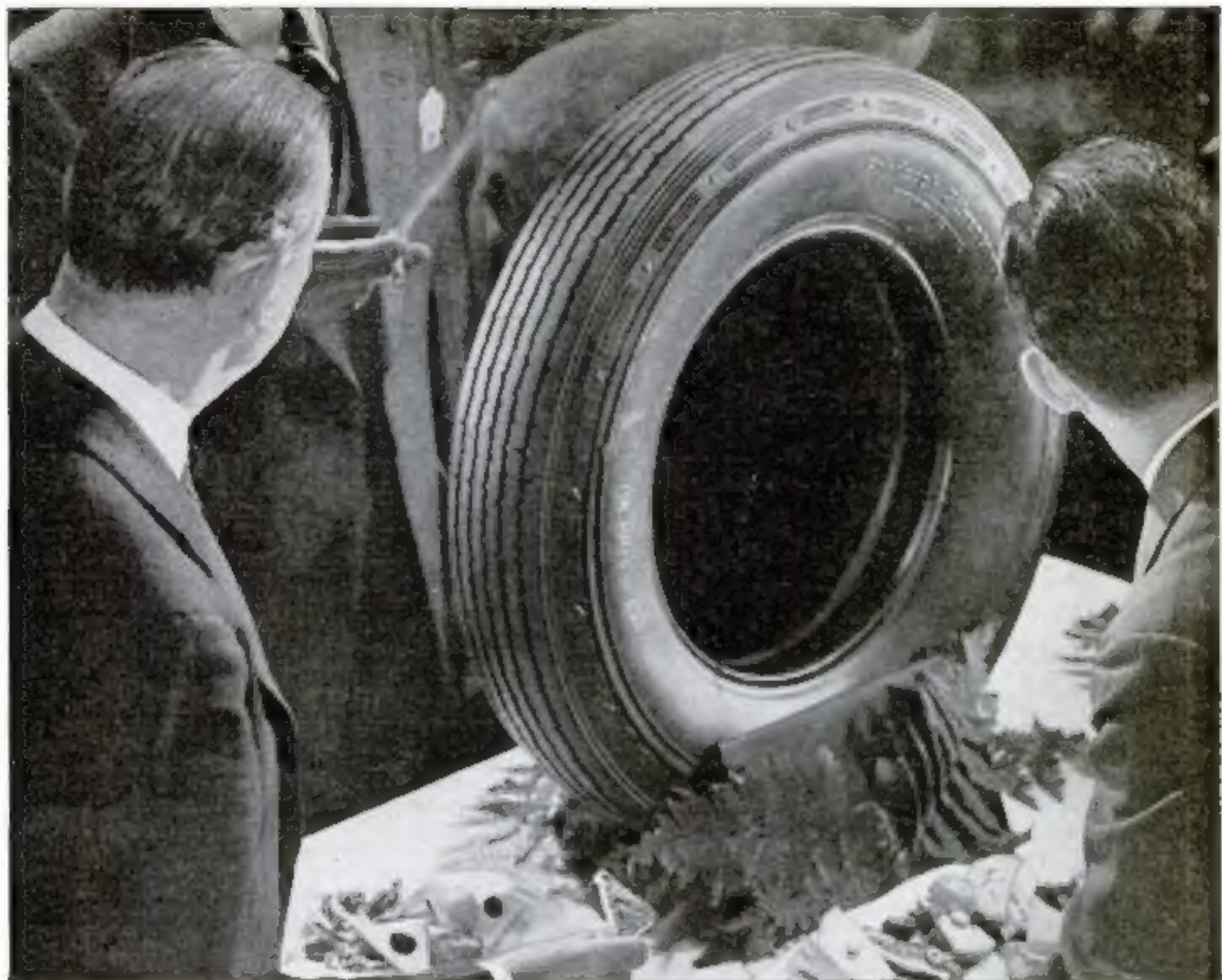
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GENERAL MOTORS SYMPHONY OF THE AIR
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Fisher

D I V I S I O N O F G E N E R A L M O T O R S



Reception for an automobile tire

The guests asked a question that was answered 80 million miles later

THEY WATCHED intently that June afternoon in 1940, eighteen months before Pearl Harbor. A tiny cardboard ship moved across a map of the Atlantic Ocean. The president of B. F. Goodrich described the little ship's voyage—bringing rubber from Malaya through the Suez to New York.

Suddenly the ship exploded, disappeared. The businessmen, editors and reporters in the Empire Room of New York's Waldorf-Astoria got the point even though many still said it was "a very remote possibility."

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Today they have totaled more than 80,000,000 miles. And the question everyone had asked—"How good is synthetic rubber, anyway?"—is answered by actual reports from car owners. Mileages in excess of 30,000 miles were reported. Some reported as much as 50,000 miles!

The tires that B. F. Goodrich makes for passenger cars today are all-synthetic (98%) and are almost as good as the tires that were made before the war. Truck tires aren't yet as good, especially in intercity service with overloads, but are being improved day by day. But the important thing is those extra years of experience . . . they are the reason so many motorists who qualify get their tires from B. F. Goodrich Silvertown Stores and dealers. *The B. F. Goodrich Company, Akron, Ohio.*

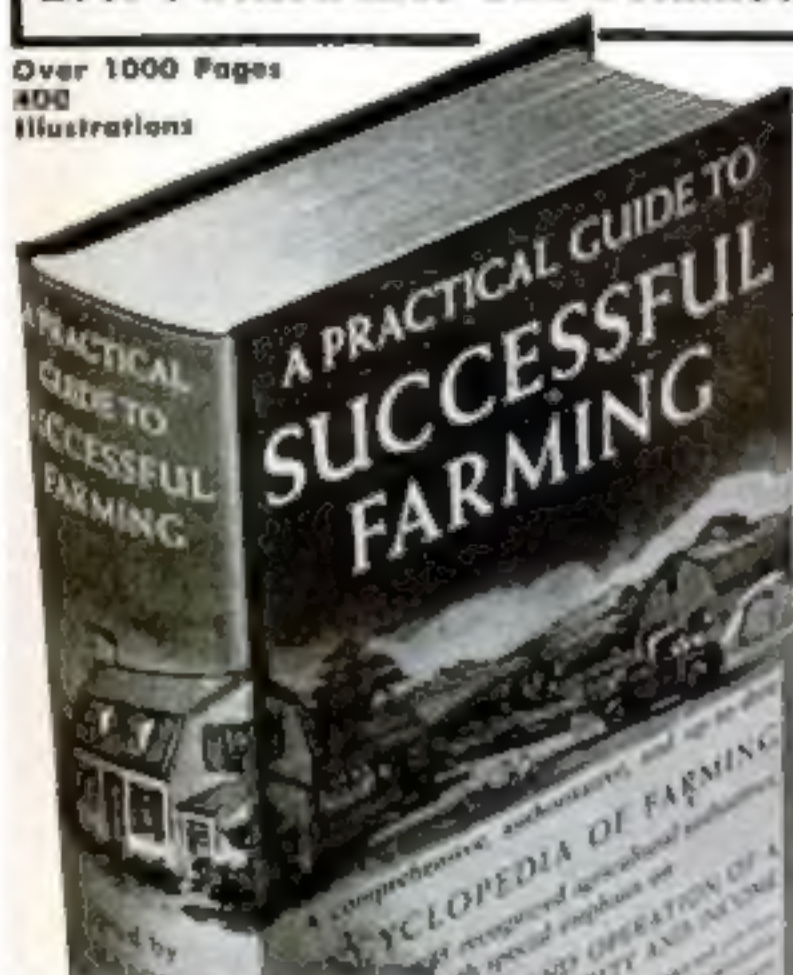
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A PRACTICAL GUIDE TO SUCCESSFUL FARMING was written, under the editorial supervision of Wallace S. Moreland, by 35 outstanding authorities on all modern farming enterprises. Including—Poultry Farming; Dairying; Raising Cows, Pigs, Sheep and Goats; Animal Breeding and Nutrition; Raising Vegetables, Tree Fruits, Grapes and Small Fruits; Bees and Honey; Grain Crops; Cultivated Forage Crops; Grass-land Farming; and Flowers.

There are comprehensive sections on Farm Financing and Management; Farm Structures and Equipment; Plant Pest Control; Soil Conservation and Improvement; Seeds and Seed Testing, etc., etc. You get the latest methods of producing for profit in 21 different kinds of farm enterprise, each covered in a comprehensive, detailed section by a recognized expert. Here is the long needed, complete encyclopedia of farming—for either beginner or veteran!

You Get Scientific Information Plus Practical Experience

The 35 agricultural experts who have written this book have assembled the accumulated experience of successful farmers as well as the proven results of scientific research. This information is presented clearly and concisely, often in convenient tabular form. Where a picture or a graph or a chart will tell more clearly what it would have taken a page of text to describe laboriously, a picture or graph or chart is used. The book contains some 400 such illustrations.

The emphasis is always on the practical and the specific—how to get more out of fertilizer by dissolving it in water, how to prevent the spread of fowl infections, what crop rotations are preferable with corn, what proportions of what ingredients are best for the winter ration of growing pigs, how to construct a goat farm.

An Encyclopedia of Farming —for Beginner or Veteran

An appendix of handy tables of agricultural information, supplementing those included in the main body of the book, helps to make this an encyclopedia reference work on farming. The type of information so presented includes: control of common insects attacking vegetables; formulas for making dusts and sprays; classification, symptoms and remedies of livestock diseases; planting data for truck and market garden crops; dates of first and last frosts; amount of seed required to plant an acre; program of fertilizer rotation for a 6-plot pasture; honey prices by States; rations for swine fed in the dry lot. A table-index immediately following the table of contents make it easy to locate any one of the many such tables throughout the volume.

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POPULAR SCIENCE

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MONTHLY

VOL 144 NO. 6

Mechanics & Handicraft

A TECHNICAL JOURNAL OF SCIENCE AND INDUSTRY

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LETTING THE CALENDAR CATCH UP

TO BRING the date when **POPULAR SCIENCE MONTHLY** goes on sale closer to the date on the cover of the magazine, the July 1944 issue will be published on June 9, the August issue on July 19, and the September issue on August 30. Thereafter, each issue will be published on or about the first of the month that is shown on the cover.

Subscribers will not lose by this adjustment of our publication date, as each will receive the full number of issues to which his subscription entitles him.

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Coming Next Month

THE SAME SILVER that Europeans used to laugh at us for digging out and then burying in our Government vaults as bullion is now doing any number of amazingly efficient jobs on both the home and battle fronts. Without it, our war production—and, incidentally, our Lend-Lease matériel—would be 50 percent less. Read about the metal that, drafted from the U. S. Treasury, is doing a better job than the metals it has replaced.

ACTION ON A DESTROYER—is that what you want? Then come along with Commander W. H. Groverman into the South Pacific, where it is all in a day's work to help rout a Jap force of nine ships, fight off a 100-plane attack, and prow through the night picking up survivors from friendly ships while enemy planes strafe your decks.

VERSATILE is the word for the two-engined Douglas plane that, in its various incarnations, has been annoying the Nazis no end by its exploits as attack bomber, night intruder, ground straffer, medium-altitude bomber, and night fighter. Whether you know it as the Boston or Havoc, A-20 or P-70, you'll be thrilled by the story of its many metamorphoses.

INDIAN FIGHTERS USED KNIVES, and so do Rangers, Commandos, and other in-fighting men in Allied forces. The need for hunting knives is great, but they are rarely found on the market today. You can make a knife of this kind, however, with no more than average skill. Next month, Walter E. Burton gives you a careful explanation of the steps involved.

A LUXURY MODEL that's easy to look at, a light reliable that costs little to run, a rugged buggy for hunting and fishing trips—these are the three types of cars that Popular Science readers told us they would like some day to own. You'll be startled at the general demand for gadgets. You'll enjoy the handsome drawings that Stewart Rouse has made for this article.

WE ASKED A MAN WHO KNOWS electronics—Carl Dreher—to write a series of articles that would tell, without exaggeration and in clear language, what may be expected of this science after the war. The first will be about the coming applications of electronics to communications, a fascinating subject treated with authority.



"Swifter than a race horse it flew over the icy streets!"

MANY a mustache cup was put down with a clatter. Many a housewife on this wintry Sunday in 1900 dreamed of a new family carriage—*without a horse!*

There on the front page of the newspaper was the thrilling story. Henry Ford had given a reporter a ride in the first Detroit-built automobile—an experimental model. It had been an inspiring experience.

A speed of 25 miles an hour had been attained. The reporter nearly leapt overboard in fright, but had successfully kept his perch over the three-gallon gas tank.

He was now able to record ecstatically that the "big machine rode with dreamlike smoothness"

despite ruts . . . that it "stopped within six feet" and then was off again "like a frightened ghost".

Mr. Ford had proved himself "an expert in cutting circles and other fancy figures". He turned sharp curves "with the grace and ease of a wild bird". Even a milk wagon and a loaded dray were encountered without mishap!

From these early days, the name Ford has never ceased to be news.

The reason lies in the basic Ford principle: *build a sturdy, simple car priced within the reach of the greatest number.*

When production was stopped on the 1942 models, more than 30,000,000 Fords had taken to the

road. Millions of them are still serving America's vital needs.

Much current news of Ford is "restricted," for it has to do with mass production of giant aircraft and other tools of victory.

But there will come a day when Ford news will again feature civilian models. You may be sure they will reflect all the ingenuity and precision engineering traditional with Ford.

Yes, the Ford cars of the future may even challenge the descriptive powers of that forgotten reporter who, at the turn of the century, rolled along the streets of Detroit "swifter than a race horse".

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JUNE, 1944



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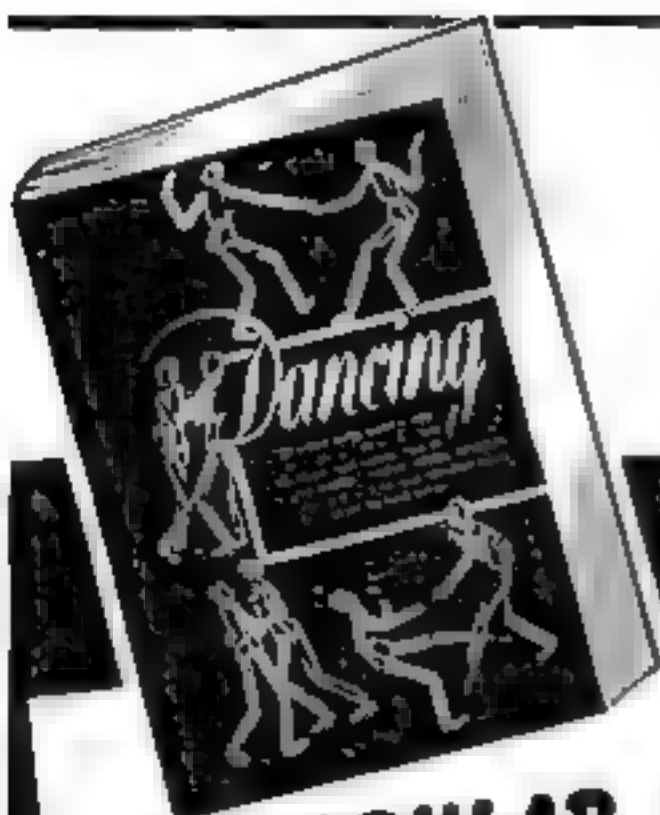
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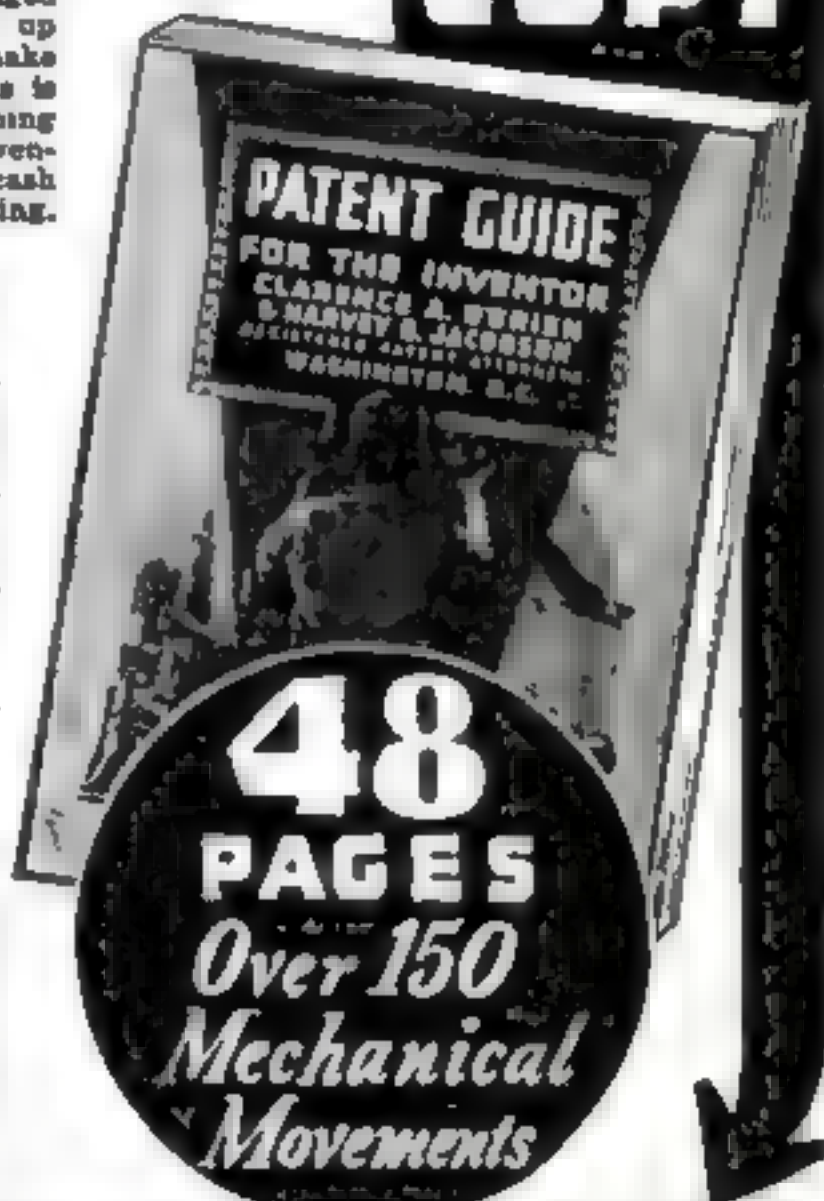
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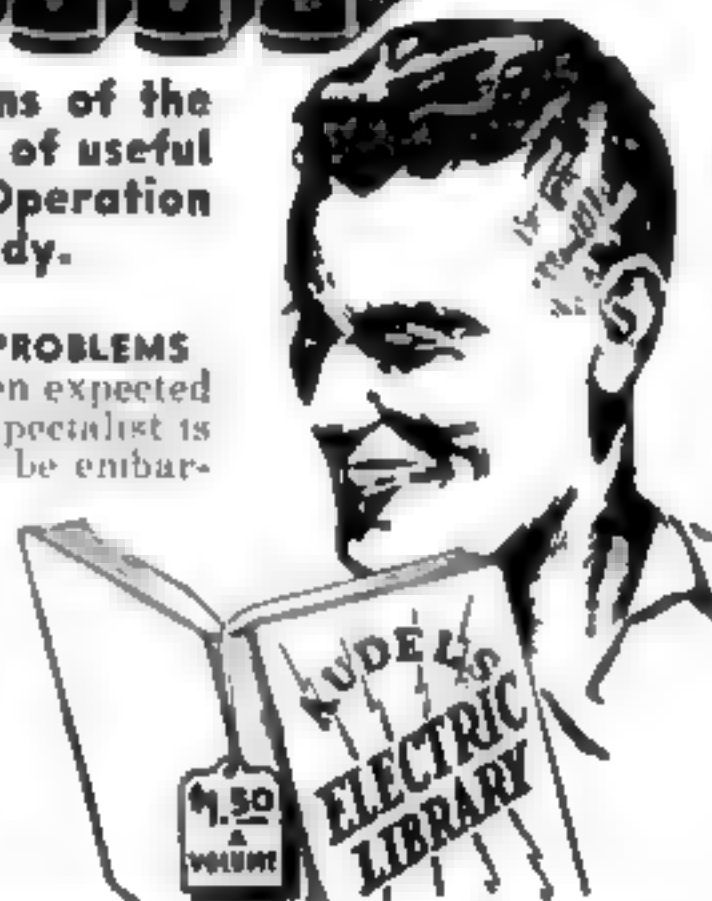
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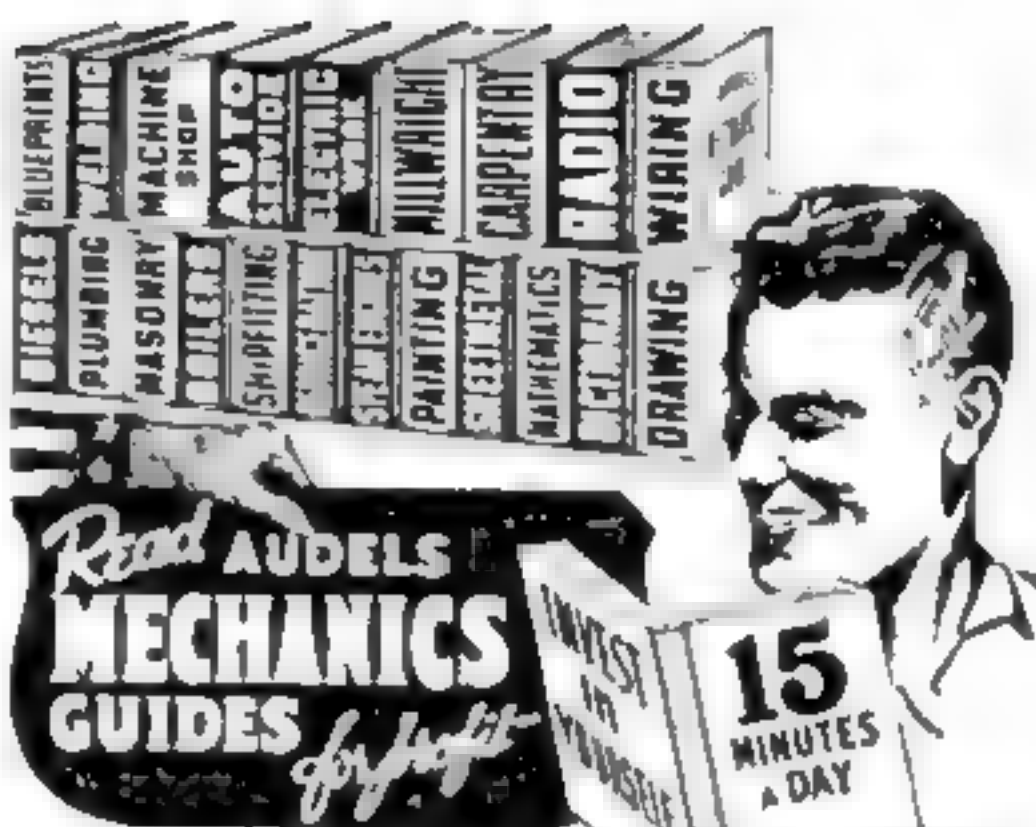
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Readers Say:

Importance of Microscopy Cannot Be Magnified

I WAS overjoyed to see in the March issue an article on microscopy by Morton Walling. Now please, please keep them up. There are a lot of us amateur microscopists just waiting for the day when the articles on chemistry and microscopy will become regular features as in the older issues. There are still plenty of used 'scopes and equipment to be picked up at second-hand shops, and, once a 'scope has been obtained, the rest is easy. Incidentally, some articles on chemical microscopy would be very fine for the majority of us who are interested in both fields. While I'm at it, please keep your magazine on science, and instead of so many articles on military machines, airplanes, guns, etc., have some on pure science.—P. E. G., Norwood, Pa.

P.S.M. Helps Dad Understand Soldier Son's Work

I CAN understand more what my son in the 650th Engineers Topographical Battalion is doing after reading your most interesting articles and pictures. I refer especially to "Superspeed Mapping," in the January number, and "The General Gets His Map," in March.—C. S. G., Toledo, Ohio.

Can Anybody Suggest a Harmless but Effective Weep-on?

TRY ARGYROL—



HELP, HELP! I'd appreciate it if some reader could answer this problem: I'm going on a trip next summer, and for protection I'd like to find a compound which, though not permanently harmful to the eyes, would quickly dampen an attacker's enthusi-

asm and make him unable to see for some minutes. It should be capable of being squirted from a water pistol. Any other suggestions on cooling the ardor of thugs will be gratefully received and carefully considered.—J. O. Y., Bala-Cynwyd, Pa.

We don't countenance the use of any weapon that would cause even temporary suffering to a black-hearted assailant. Our suggestion for effective defense would be to carry a copy of the Congressional Record and read it to the evilly-disposed person. But there may be still better ideas advanced.—Ed

Any Wild Duck's a Goose to Stay in New York

ON A few occasions in New York City I visited Central Park, and was quite interested in the wild-life collection, especially the ducks in the pond. As I sat on one of the benches, I saw people feeding them chunks of bread, crackers, peanuts, popcorn, and what have you, which they gobbled down with seemingly great relish. They came swimming from every direction, and when some saw they were losing the race, they flew a little. I believe some were mallards. As I watched this spectacle, I wondered, with revulsion, that these ducks seemed quite happy in a place where the noise and people would drive a wild duck to drink. I wish someone would tell me why these perfectly sane (?) ducks would rather stay in this place instead of flying away to some marsh where respectable ducks belong.—S. Y., Ellenville, N. Y.



Here's a Long Look Ahead to Next Winter

YES, C. E. H., I have an idea how to make a small electric thawing device. Turn back to page 153 of POPULAR SCIENCE for January, and build that soldering transformer described by Harold P. Strand. When you get ready to make the ground clamp and carbon holder, just make two ground clamps instead, and clamp one on each end of the section of the pipe that you want to thaw. I'll bet it will be plenty good for thawing your pipes. After all, if it thaws too quick to suit you, you can put an inductance coil in series with the primary winding, but if it doesn't thaw quick enough, I guess you'll just have to build another transformer.—R. L. D., Seattle, Wash.

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Readers Say:

Continuing to Swing Those Vacuum-Cleaner Blues

THIS will answer S. S.'s question in the March Readers Say. The column of air inside the vacuum-cleaner tube vibrates as a whole at a certain frequency, and its harmonics depend on the length of the tube. This can be compared to a wind instrument such as a trumpet. With no keys depressed, only a few notes, all harmonics of a basic tone, can be sounded. Other notes are played by varying the length of the tube by depressing keys, thus changing the basic tone and its harmonics. S. S. has inadvertently discovered the underlying principle of many wind instruments. I might note that in olden times musical instruments were without valves. Instruments of different lengths, and thus with different harmonics, were alternated while a piece was being played.—E. H. M., Jr., Hillsdale, Mich.

Add Similes: As Wrong as a 1937 Atlas

ACCORDING to my atlas, Burma is part of India. But you make them out to be separate in your recent article on flying supplies to China. Which is wrong?—J. H., Caldwell, N. J.

Your atlas, Burma was detached from British India, and made a Crown colony, in April 1937.—Ed.

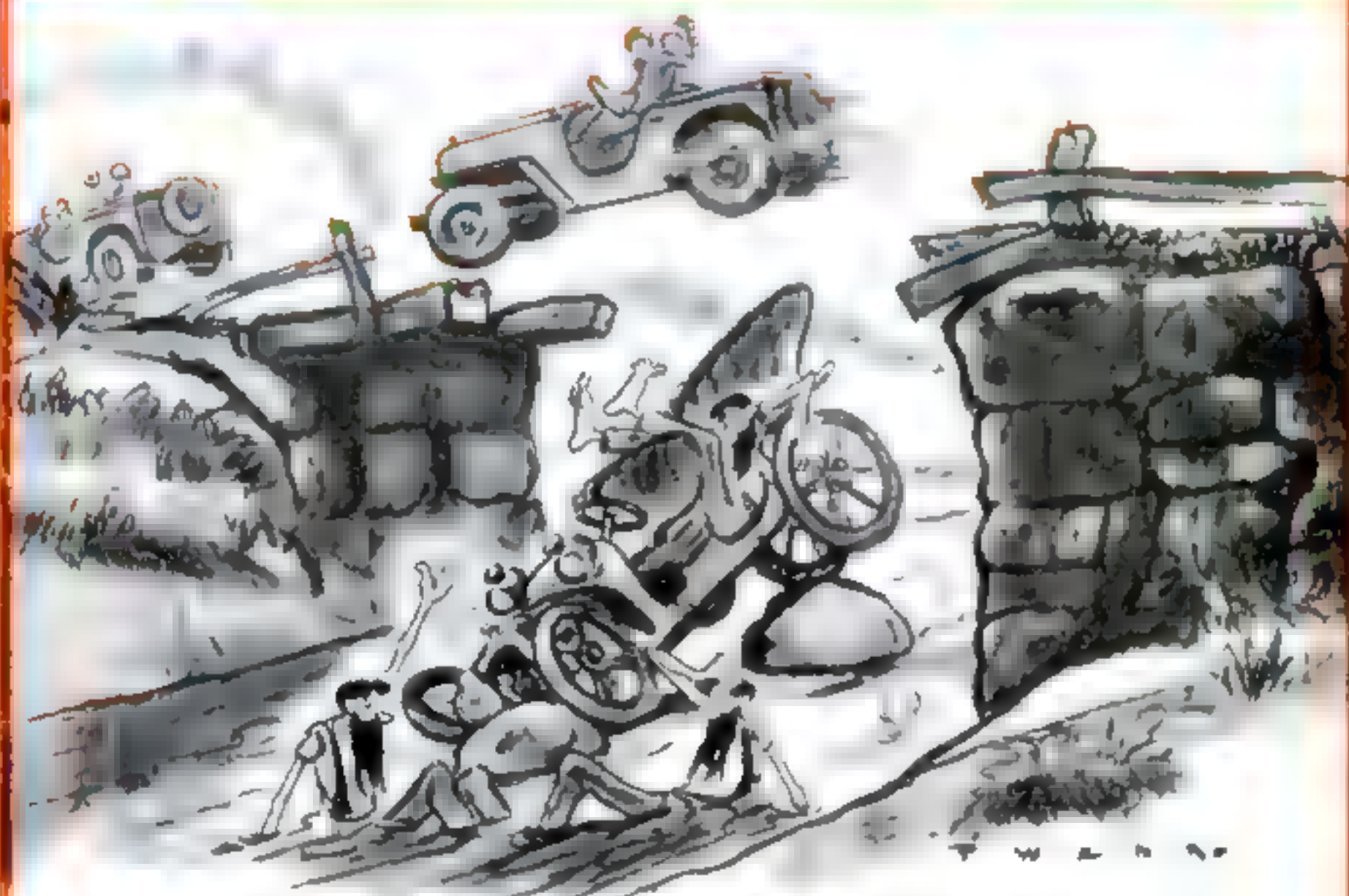


We're Glad to Give Credit Where Credit Is Due

WE wish to call to your attention that the first three pictures appearing in your article "Tiny Ball Bearings" (April issue) should have been credited to Miniature Precision Bearings. So that other readers may not be confused, the bearings ranging from 1/8-inch to 5/16-inch outside diameter and described in your article are manufactured largely by this firm. The larger bearings illustrated are made by other antifriction bearing manufacturers.—H. D. Gilbert, Treas., Miniature Precision Bearings, Keene, N. H.

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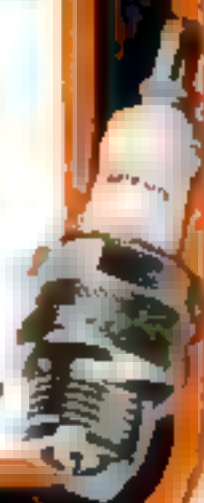
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Readers Say:

Air-minded Young Man Is Set Straight on Inverted Flying

I AM a boy of 16, but I know the general fundamentals of aviation; that is, the general shape of the wing and why an airplane flies, etc. But there is one problem that I have puzzled over for a considerable time, and I wonder if some of those bright brains in Readers Say could solve it for me. The cross section of an airplane wing is roughly that shown in diagram A.

The airstream follows the direction of the lines, producing a partial vacuum which lifts the plane off the ground. But when the plane flies upside down, the wing takes on the shape shown in B. The "lift" is turned downward to aid gravity (supposedly), and it seems to me

that in that case the plane would fall to the earth faster than if it just stopped in the air and fell, having the urge of gravity plus the push made by the shape of the wing. Just what does happen when a plane flies upside down?—W. B. R., Atlanta, Tex.



We consulted our Aviation Editor, O. B. Colby, about this, and here is what he said: If a plane flew perfectly level when it was inverted, there is a probability that it would lose altitude rapidly, but when planes are flown inverted, they do not fly level. Planes flying inverted fly with tail low as in the sketch C, with the result that their wings are set at a positive angle of attack to the air in spite of their being inverted. For this reason they are capable of sustaining flight in this position. The inverted wing is not as effective, of course, as when in normal position, but inverted flight can be maintained.—Ed

Magazine Wows; Editor Bows

I LOOK forward to P. S. M.'s arrival with the eagerness of a five-year-old going to his first show, and when it arrives, I read it from cover to cover. I most delight in the Readers Say columns, the aircraft paintings, the woodshop plans, and the Home Chemist features. P. S. M. is getting better all the time, and is worth all you charge.—R. E. F., Providence, R. I.

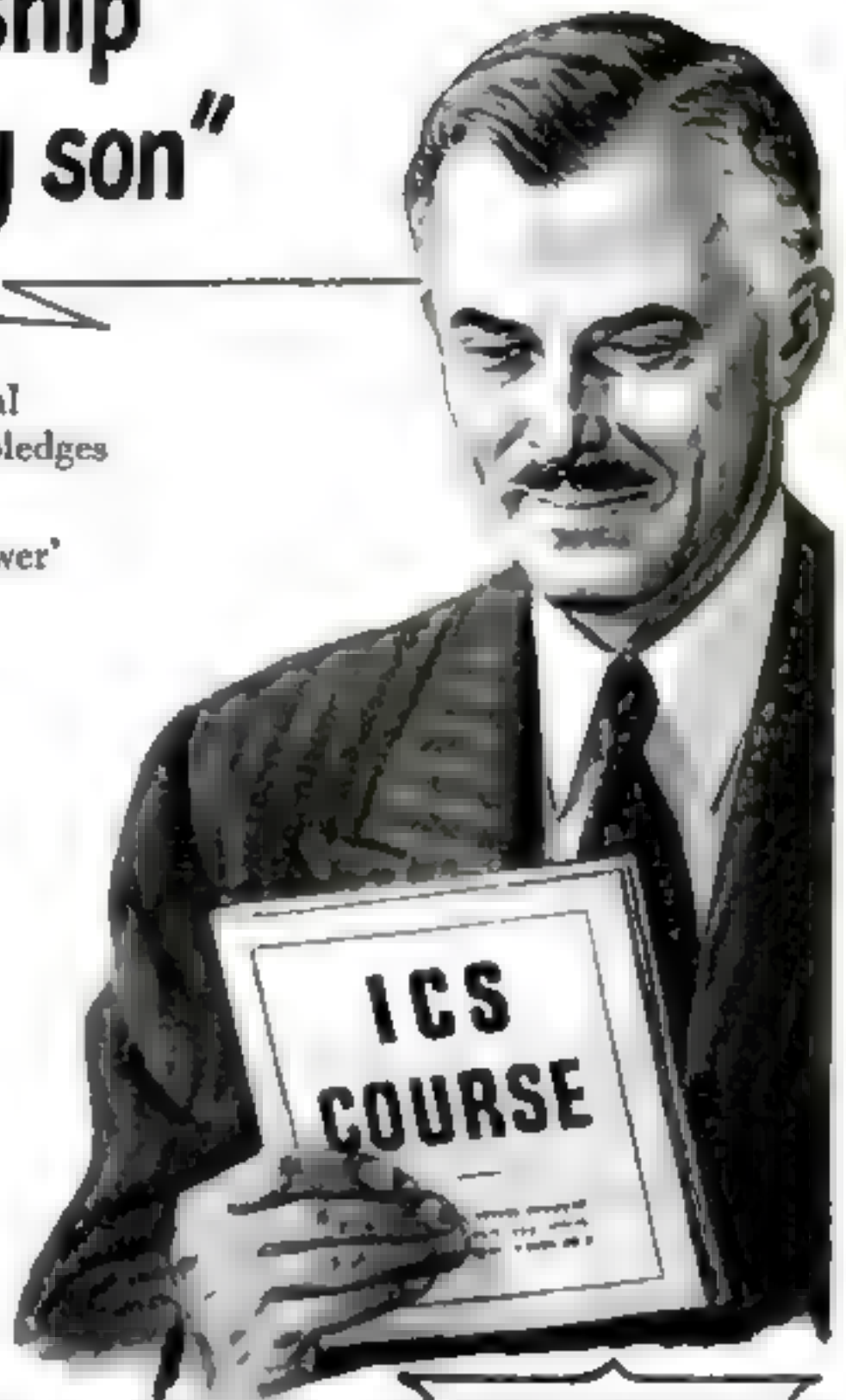
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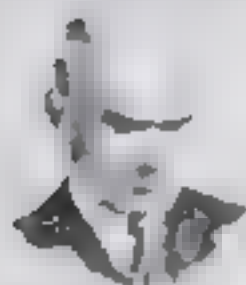
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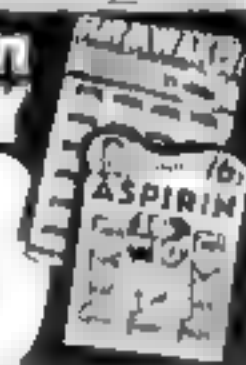
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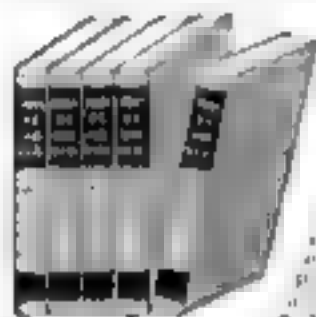
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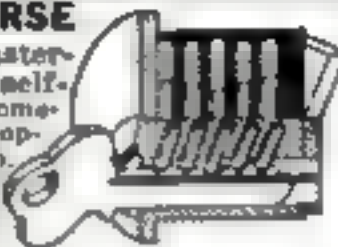
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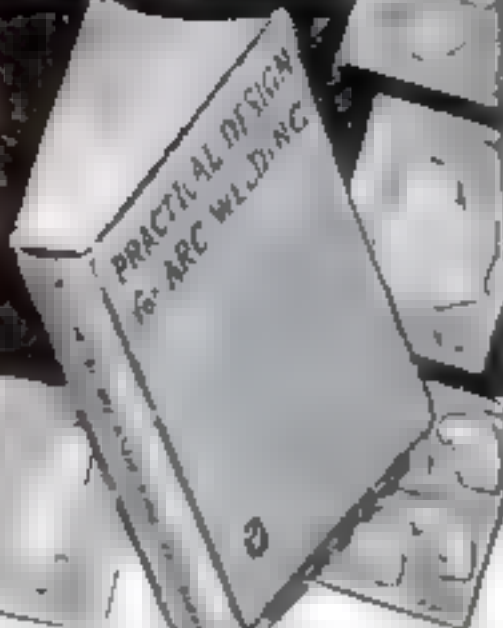
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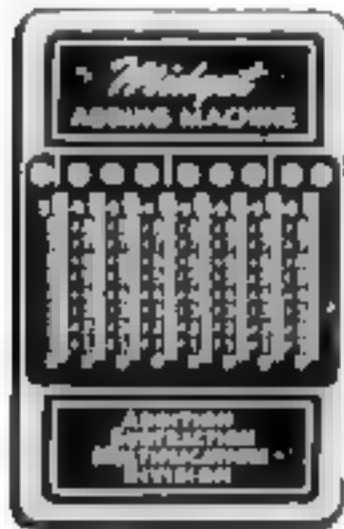
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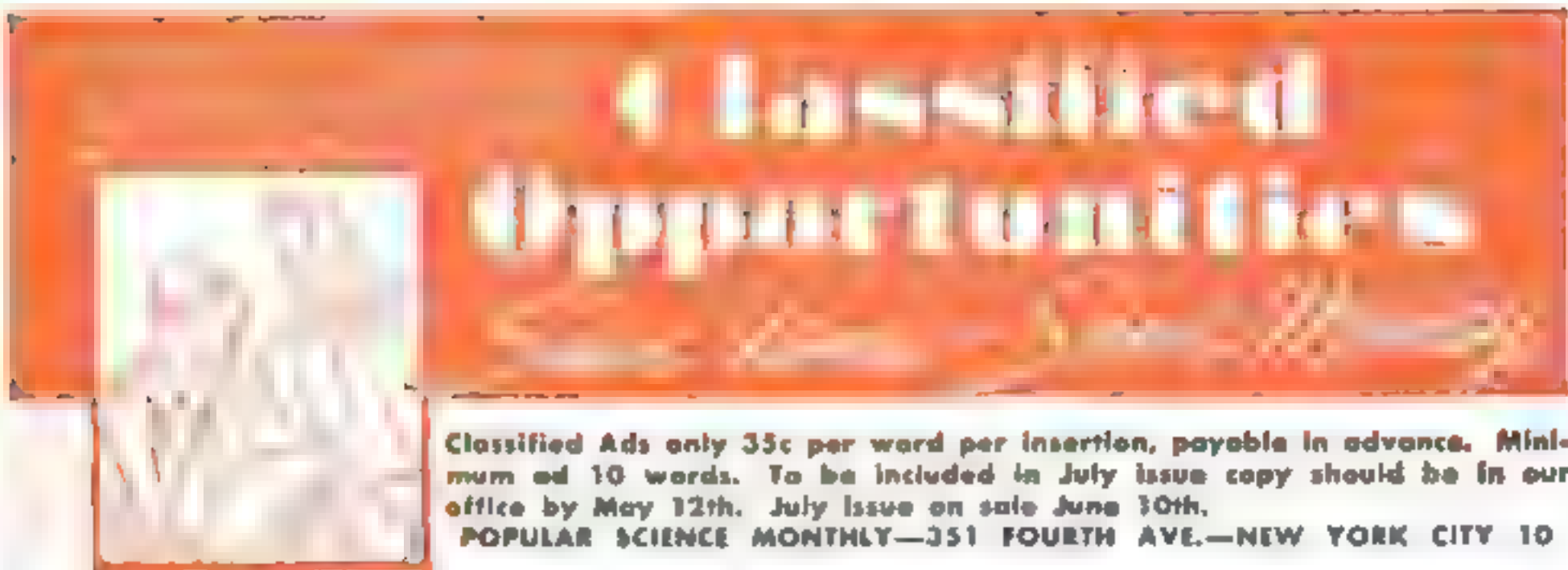
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As a first step in their progress toward the Power that Knowledge gives, Mr. Dingle wants to send the readers of this notice a 9,000-word treatise. It is free. For your free copy, send your name and address to the Institute of Mentalphysics, 213 South Hobart Blvd., Dept. J-388, Los Angeles 4, Calif. Write promptly.



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WAR CASUALTY? The thoughtful look on this cockroach's face may be due to the fact that he has seen the handwriting on the wall. War-born insecticides mean hard times ahead for him. (Photo: Rohm & Haas Co.)

Another Enemy Surrenders

HERE is news that should relieve the boiling discomfort of summer days. At last science has found the weapons for total victory on the insect front. Conquest of the biting insects that plague man means hope to millions who die every year of mosquito-borne diseases, millions more racked by mosquito-borne dengue fever. It means freedom from the terror of louse-borne typhus fever, from tick-borne Rocky Mountain spotted fever, if this research can continue and the results produced by it are intelligently used.

One case of tuberculosis in five, much dysentery, enteritis, and typhoid fever have been attributed to the common house fly. Total victory on the insect front will not eliminate these scourges. But it will go far toward reducing their danger.

Disease-bearing insects, worst foe of jungle fighters, are on the run before new weapons that will mean better health and more comfort for everyone in peacetime.

By ALFRED H. SINKS

Photos from U. S. Department of Agriculture

For thousands of seashore resorts, for many a hunting or fishing spot, effective control of biting pests will mean the difference between popularity and failure. Control of mosquito larvae alone has raised the value of seashore property in four New



THE MOSQUITO, a carrier of yellow fever and malaria, is enjoying small pickings these days because of a new repellent developed for soldiers in the tropics



PLANES flying into the U. S. from foreign countries are sprayed with an insecticidal aerosol to kill off any disease-carrying bugs that may have stowed away

Jersey counties by \$100,000,000 in 20 years!

It will change the whole aspect of life for hundreds of millions of people who live in tropical and subtropical countries. It will unlock the doors to vast areas where disease-bearing insects have barred the way to development and progress. In summertime we can forget our ineffectual counterattacks with old-fashioned fly sprays, our evil-smelling citronella oil, the flypaper that messed up the house but failed to disturb the flies. We may even forget how to scratch

Shortly after Pearl Harbor, chemists and entomologists of the U. S. Department of Agriculture began a search for means to protect our fighting men against attack by insect pests and the menace of insect-borne disease. Largely as a result of that search our Army today is more free from disease than any other army in the world at any time in history. Within the past few months scientists of the Bureau of Entomology and Plant Quarantine have perfected three new weapons against man's age-old enemy:

First, a powerful insecticide that can be made cheaply in great quantities. In powder form, dusted on underclothing or inside the cuffs of shirts and trousers, dichlorodiphenyl-trichloroethane—or DDT—protects against body lice and to some extent against ticks and chiggers. Used in a spray, it will make your living-room walls themselves toxic to flies for as long as three months after one spraying! Yet this remarkable chemical is not even faintly irritating to men or animals.

Second, a new chemical compound for use outdoors to keep insects away. This new repellent—a combination of three substances formerly used—is three times as powerful as citronella. Yet it is nearly odorless, and is harmless to skin or clothing.

Third, aerosol. Aerosol is not an insecticide. It is a startling new method for

using the weapons we now have against the insect hordes, making them many times more effective.

Back in 1935 a 30-year-old chemist by the name of Lyle D. Goodhue came to work in the Bureau of Entomology's laboratory at Beltsville, Md. One day in October he pulled a well-filled notebook from the drawer of his desk and jotted down this random thought: "Why could not a gas like Freon—which liquefies under a few pounds' pressure and boils at 21 degrees below zero Fahrenheit—be used as a solvent and propellant for insecticides?" That was how aerosol insecticides were born.

An aerosol is a suspension of fine particles in air or gas. The common oil-spray insecticides consist of heavy droplets that quickly fall to the ground or settle on your floor, walls, or furniture. In an aerosol the bug-killing substance is far more finely divided. The particles may be as little as 1/25,000,000 of an inch in diameter! Because they are so tiny, they float for a long time in the air—exactly like smoke or fog—and ultimately find their way into all protected places. Aerosols have been known to hover for as much as five hours in still air!

Among all the insecticides yet discovered, pyrethrin is the most deadly to mosquitoes. Released in an aerosol, it is at least three times as effective as it is when dissolved in oil spray. Compared with oil spray used in a cheap spray gun, the advantage is far greater than that. Five milligrams—one very small drop—of pyrethrin extract will in one minute kill every mosquito in an average room of 1,000 cubic feet!

This amazing discovery was bad news for the Axis. After Pearl Harbor it was clear that much of our fighting would have to be done in the fever-ridden tropics.

Malaria is the most crippling disease known to military history. It has knocked



AN AEROSOL "BOMB" set off in an Army barracks will injure no one but an insect. The bomb contains a pound of liquid insecticide that is released in a spray

out entire armies. In Salonika, from 1915 to 1918 it almost paralyzed both the German and Allied armies. India alone has 100,000,000 cases and a million malaria deaths per year. In Liberia and other parts of Africa, yellow fever, though rarer, is even more deadly. As many as 70 percent of its victims die. Both diseases are carried by mosquitoes.

There is a vaccine that gives fairly good protection against yellow fever, but medicine knows no method of immunizing against malaria. And the Japanese conquest of Java left us critically short of quinine, the standard drug for treatment of the disease.

Mosquito control was the only answer. But we were also critically short of pyrethrum, the source of pyrethrin!

Before the war we got a certain amount of pyrethrum from Japan. But since Pearl Harbor, Africa has furnished our entire supply. The pyrethrum flower—a cousin to the common field daisy—is cultivated extensively in the vicinity of Lake Tanganyika. About half of the crop goes to Britain and half to us. If this precious store of mosquito-killer had to be used in ordinary sprays, we should not have a fraction of what we need to protect our troops.

By good fortune Dr. Goodhue began experimenting on aerosols in January 1941. He was not thinking then about the danger and discomfort caused by insects to man. He was looking for a better agricultural insecticide. Working with an associate, William N. Sullivan, he tested various ways of producing aerosols. One of their early methods was to spray insecticide liquid from a compressor against a hot plate. Even when produced by this crude apparatus, aerosols were many times more effective than ordinary sprays.

Then, one day in October, Dr. Goodhue thumbed through his notebook and ran across his note about Freon.



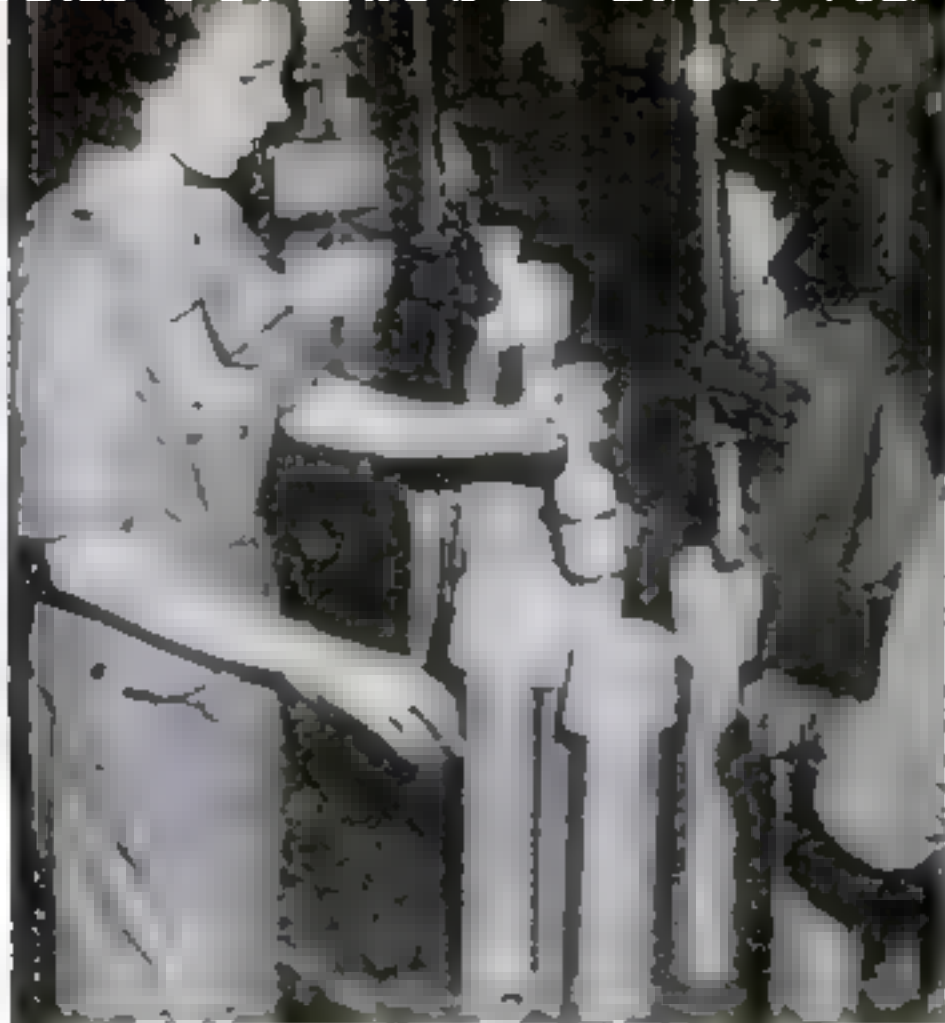
W. N. SULLIVAN, one of the developers of the aerosol method of dispensing insecticides, tests a rotenone solution as a fumigant. The solution vaporizes on being sprayed on a hot plate

Freon is a synthetic organic compound. For many years it has been manufactured and sold as a refrigerant. More likely than not there is some of it gurgling through the cooling system of your kitchen refrigerator!

Under compression, it is a liquid, colorless and tasteless as tap water. Released into the air, it instantly becomes a harmless gas. You can't see it or smell it, and it is both nonpoisonous and noninflammable.

Pyrethrins dissolve perfectly in Freon. Released from the valve of a metal container, the expanding gas spreads the molecules of mosquito-killer in a fine mist. Freon maintains enough pressure to propel the solution into the air as long as a drop remains within the cylinder. None of it goes to waste.

(Continued on page 231)



Filling six-pound M-69 incendiary bombs. Jelly flows from a mixing vat above and is packed with a plunger

THE GENTLER SEX turns out a mean bomb. Through pipes from the overhead mixing vat these young women are filling M-69 six-pound jellied-oil incendiary bombs. Dropped preferably on an Axis position, the hexagonal missiles explode on impact with spectacular effect. When they burst, they spray flaming oil and rubber from the tail as far as 75 feet in every direction. The bombs are of two kinds, one containing "gel-gas," a resin-type jelly, and the other a composition that is mixed with gasoline. These bombs also are clustered.

Four Chemical Warfare Service arsenals and hundreds of civilian plants are making aerial incendiaries. Factories that have been converted to this work include those of manufacturers of baby shoes, vacuum cleaners, washing machines, outboard motorboats, fireworks, and other peacetime articles. Four days after Pearl Harbor, incendiary bombs began coming off the assembly line; since then, production has shown a steady increase.

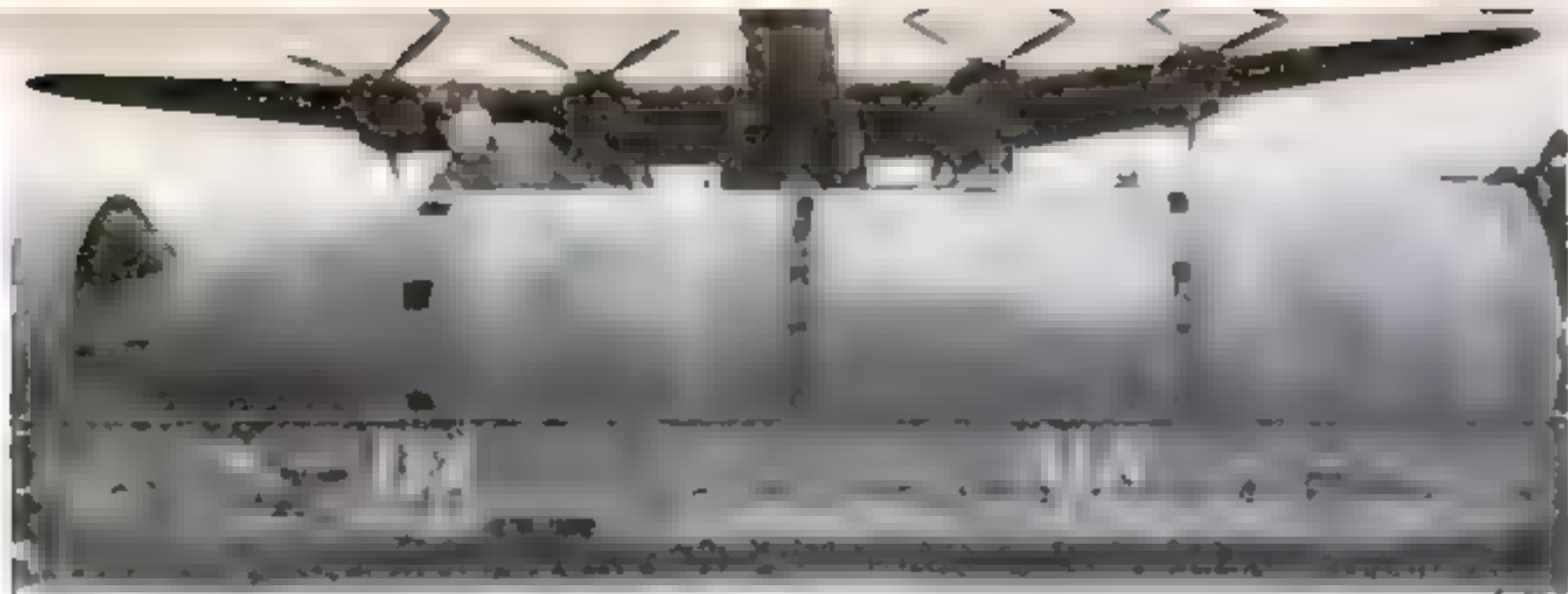
TWO-WAY TRAIN TELEPHONES using electronic principles have been installed on the freight carriers of the Pennsylvania Railroad along the 67-mile Belvidere-Delaware branch running northward from Trenton, N. J. The system, first of its kind in railroad history, was produced in collaboration with the Union Switch and Signal Company. Crews of freight trains can talk with block operators in wayside towers for transmission of orders regarding trains that are in motion. Electrical principles of both radio and the wire telephone are used in the new system, which employs transmission paths confined to railroad property and obviates the necessity of appropriating limited radio wave lengths.



A dud Nazi "butterfly" bomb, which was dropped on Anzio beachhead and failed to do its stuff. In midair this bomb normally separates (see two empty sections at its right), and scatters delayed-action bombs over a large area



DEATH with a pretty label lurked in this Nazi "butterfly" bomb, which failed to function when it was directed at the Allied Anzio beachhead. Like its prototype, the "Molotov cocktail," this bomb drops a measured distance from a plane, when the case opens and releases a number of small delayed-action bombs, some of which may lie on the ground for a day or longer before they explode. "Butterflies" are usually dropped by the enemy among troop concentrations.



This 12,000-pound block-buster, containing RDX, waits to be loaded on the Lancaster in the rear for eventual deposit on a Nazi target in France



In testing the deadly RDX, Canadian troops strapped a TNT charge to a tree and set it off. It did little more than take off the bark. An equal charge of RDX promptly blasted a similar tree to splinters (below)



SPEED AND PUNCH have been combined in the Armored Car M-8, latest addition to our mechanized forces. Rolling on six wheels, the eight-ton car can hit high speeds on almost any type of terrain. It carries a 37-mm. cannon and a .30 caliber machine gun. Intended primarily as a combat-reconnaissance car, it has heavy armor plate and a low turtleback silhouette that offers good protection to the crew.

RDX—SUPEREXPLOSIVE. Lambasting our enemies from all sides is a new and terrible explosive that is said to be several times more destructive than TNT. Developed by Dr. Godfrey Rotter, a British scientist, RDX has been used in the block-busters that have smashed Hamburg, Bremen, Berlin, and other German cities, and in the bombs that sank the Nazi battleship *Scharnhorst*. Allied artillery shells are also making use of the annihilative force of RDX. German prisoners have reported that such shells, landing as far as 200 yards away, have made their heads spin with the sheer concussion. Jap prisoners admit that the shells, even when bursting at a good distance, often send their forces into a panic. As for RDX block-busters, they have been known to destroy everything within a radius of half a mile.

Rotter has spent 40 years developing the formula for RDX, which contains hexamine (P.S.M., Sept. '43, p. 61) and is produced by combining formaldehyde and ammonia. Ironically enough, hexamine was discovered by the Germans, who also know the other ingredients of RDX. But what they don't know, and probably would give Hitler's right eye to learn, is how these substances are being combined to form the world's most devastating explosive. At present, RDX is being manufactured in plants all over the United States and Canada.





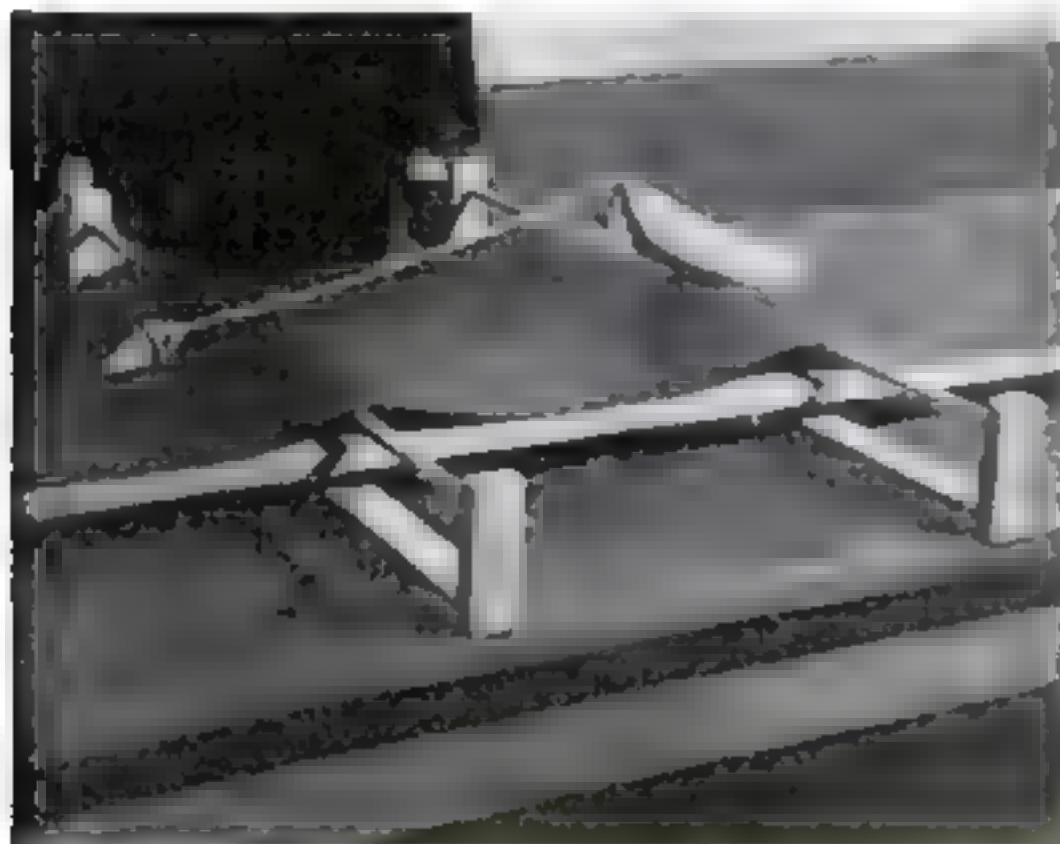
Slightly bigger than a 12-gauge shotgun shell, the cartridge at the right is used to start up airplane engines

Remington Arms technicians study target pattern made by shot-filled shell designed for use in a .45 cal. pistol



TWO SHELLS that won't be fired at the enemy have been developed by Winchester Arms and Remington Arms for rather novel purposes. The first is a shotgun type that is used to start up airplane engines while they are being tested. Replacing the conventional

storage battery, it sets the engine in motion by delivering a single powerful impulse. The other is a shot-filled cartridge that can be fired from a .45 caliber pistol and is used by forced-down airmen to shoot birds and small animals for food.

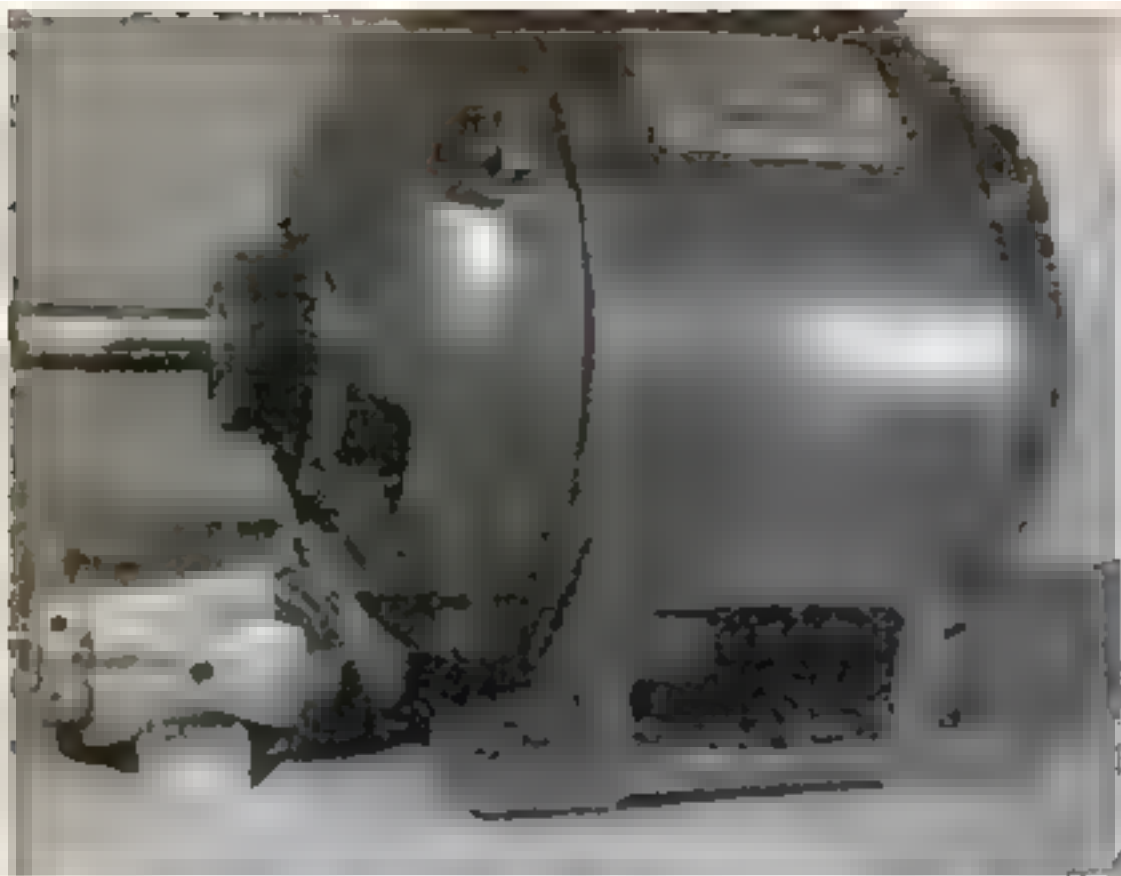


SEAMANSHIP problems are brought right into the classroom by means of an extremely clever device now in use at the U. S. Maritime Service Training Station at Sheepshead Bay, N. Y. Wooden rollers, passing under a strip of window-shade cloth that represents the surface of the sea, make the tiny boat pitch and roll in much the same manner as an actual lifeboat in the open sea. A tiny anchor is used to show students how to keep a boat headed into the waves instead of letting it turn sideways where it will be in danger of capsizing. Other "foul-weather" problems in seamanship can also be demonstrated.

NYLON, a Du Pont thermoplastic usually seen in the form of filaments in hosiery, parachutes, hair brushes, racket strings, and the like, is now appearing in injection-molded products such as those shown below.

At left is a slide fastener of FM-1 nylon, which is unaffected by dry-cleaning fluids or ironing temperatures. The nylon and cloth are united during the molding to form a strong bond. At right are injection-molded switch cases of the same material. Despite their thin walls, they can withstand heat that would distort other plastics.



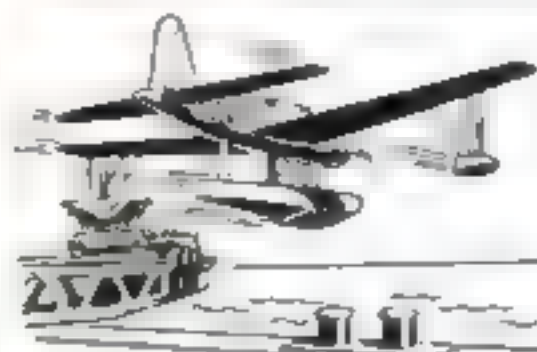


RECORD-BREAKING SPEED is developed by a new midget electric motor manufactured by General Electric for war purposes. The rotor moves at the heretofore unheard-of rate of 120,000 revolutions a minute. The midget, rated at three horsepower and weighing seven pounds, is shown at the left beside a conventional three-horsepower motor weighing 105 pounds. A more graphic indication of the size of the motor is shown as it lies in the palm of a man's hand, while the rotor is held between the thumb and forefinger of the other hand.



Heat generated by such terrific speed requires that the motor be water-cooled, and it uses about half a gallon a minute. It is also equipped with an oil-mist lubricating type of bearing, and has been tested by continuous runs up to eight hours. D. H. Ware, General Electric motor engineer, figured that if the wheels of an automobile should turn as fast as this motor, the car would travel at the rate of 10,000 miles an hour, which is more than 14 times the highest recorded speed made by an airplane in a power dive. This motor is designed for grinding and drilling airplane parts and similar equipment—jobs requiring tools with high peripheral speeds.

BAGFUL OF WATER BOILS over flame when the container is of Asbestoson fabric, a synthetic rubber-impregnated cloth made for the U. S. Army by the United States Rubber Company. This collapsible bag is carried by airmen and medical soldiers for emergencies. It can be used effectively as a cooking vessel and also as a means for sterilizing instruments.



The gun provides power to launch scouting planes from battleship or cruiser decks. The piston yanks a plane-laden cart along the catapult track, and from it the plane is thrown into the air.

LAUNCHING a plane with a gun is accomplished by powering a warship catapult with an explosive shell, whose gases rush into an expansion chamber from which a piston is operated.



BELL HELICOPTER. Still in the experimental stage is this cabin job designed by Arthur M. Young and built by Bell Aircraft Corporation. Counterbalances keep the two blades of its rotor at proper pitch

No Helicopter for You

Don't let anybody tell you that you'll have a whirligig flying flivver the day the war is over. It still has a long way to come.

By **DEVON FRANCIS***
Drawings by **STEWART ROUSE**

*Veteran pilot and first president of the Aviation Writers' Association. A close student of the helicopter, he has just completed a book on the subject.

Tomorrow

AT a plot of ground surrounded by a high board fence in Bridgeport, Conn., a test pilot for whirligig flying machines regularly plays a practical joke on Army pilots who come in for indoctrination flights. The plot of ground abuts the only factory in the United States now devoted to the volume production of helicopters. "It's all quite

PROS AND CONS . . . THE BALANCE SHEET OF THE HELICOPTER



+ Ability to rise and descend vertically gives it wider potential usefulness than any other type of aircraft. For cross-country travel, it can proceed from point to point in a straight line without regard to highways or airports. Navigation is easy for the layman pilot, as he can descend at will to any level necessary for identification of landmarks. While its practical speed (about 100 miles an hour) is slow in comparison with that of conventional airplanes, the helicopter offers private owners a new high in rapid transportation, comparing favorably with the top speeds of crack transcontinental trains.

— Only one-half to one-third as efficient as small fixed-wing planes, the helicopter gets no more miles-per-gallon than a heavy seven-passenger automobile. Still harder to fly than a conventional light plane, it is unstable on its horizontal axis, subject to icing, and plagued by assorted vibration troubles. Its complicated mechanical parts make it liable to operational failure, and it would be difficult to abandon by parachute. Because its moving parts are exposed, it is dangerous on the ground; for instance, the tail rotor used on most types presents a constant danger of people walking into the whirling blades.



simple, you'll find," remarks the test pilot disarmingly to the neophyte at his elbow, as they strap themselves into the side-by-side seat of the helicopter.

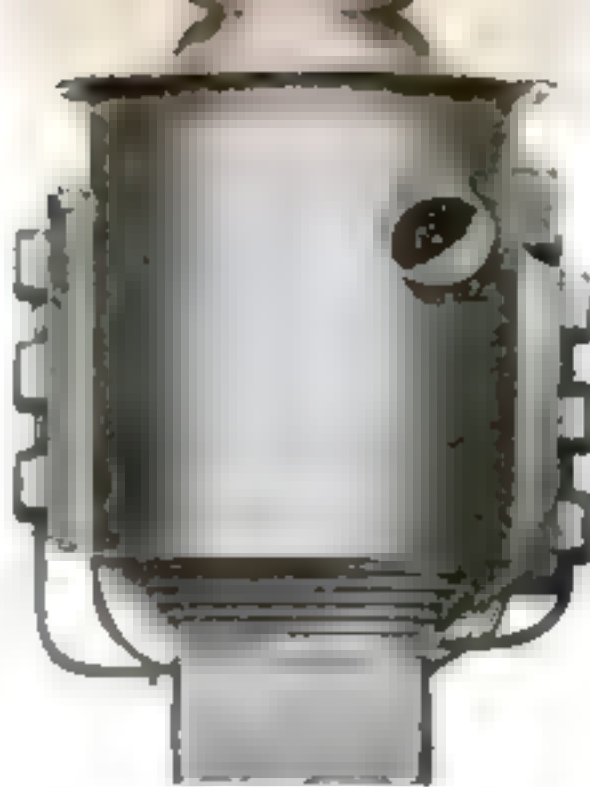
He starts his engine, engages his rotor, checks his instruments, and tests his controls.

"Now," he goes on cheerfully, "just take hold of the control stick. Sure you've got it at dead center? Let's take off."

He speeds up his engine. The pitch of the rotor blades increases. The ship lifts off the ground, straight up. At a height of about a dozen feet it hesitates. The test pilot cracks the throttle a little more to make up for the loss of "ground effect." The helicopter resumes its steady climb.

At 1,000 feet he pulls back on the throttle until he and his passenger are hanging motionless in midair.

Now comes the payoff on the joke. "Got that stick firmly in dead center?" he inquires. "No, not with one hand. Use both hands." The indoctrinee is holding onto it



HELICOPTER ENGINE built by Aircooled Motors Corporation, Syracuse, N. Y. A six-cylinder Franklin, it is mounted in a circular housing to operate vertically below the main rotor shaft

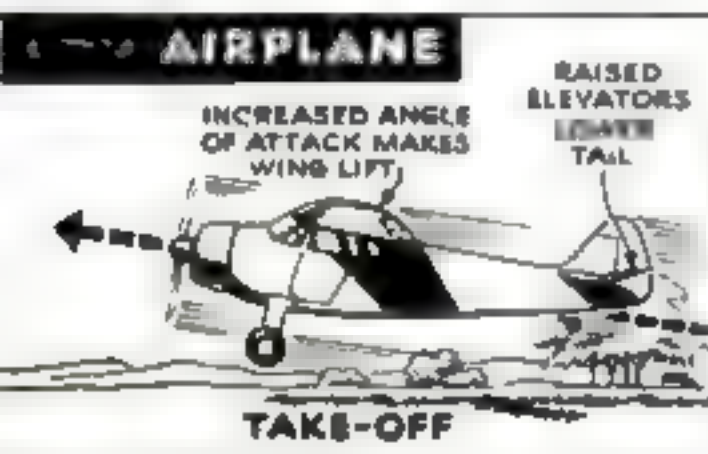
for dear life. "Okay, now watch."

Ever so slightly the test pilot puts forward pressure on his own stick. The movement is only an infinitesimal part of an inch. The Army man feels no motion in the dual controls on his side of the cockpit. At the same time the test pilot sneaks the throttle back, reducing the engine power. Imperceptibly the helicopter moves. It moves forward and, just as imperceptibly, its nose tilts toward the ground. In a minute it is in a full-blown dive. Apparently it is out of control. It must be. The dual control sticks still appear to be in dead center.

In a panic, the Army man involuntarily hauls back. Obediently the helicopter responds. As the test pilot shoves forward on the throttle, it comes out of its dive and starts climbing.

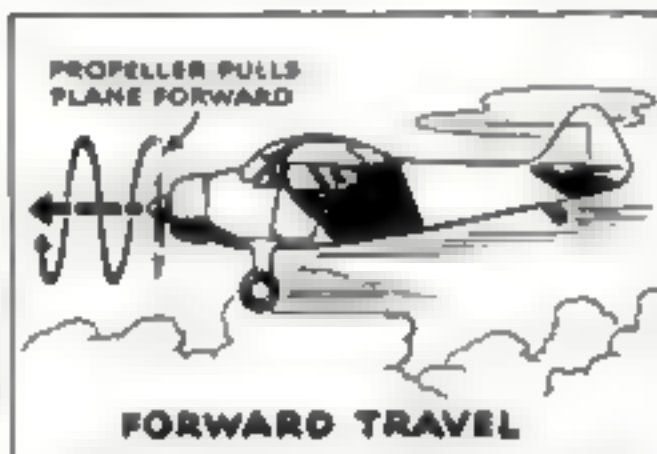
What the test pilot has demonstrated is the inherent sensitivity of the machine. No prima donna could be more sensitive, more temperamental, than these new-day whirli-

COMPARISON OF THE AIRPLANE WITH THE HELICOPTER



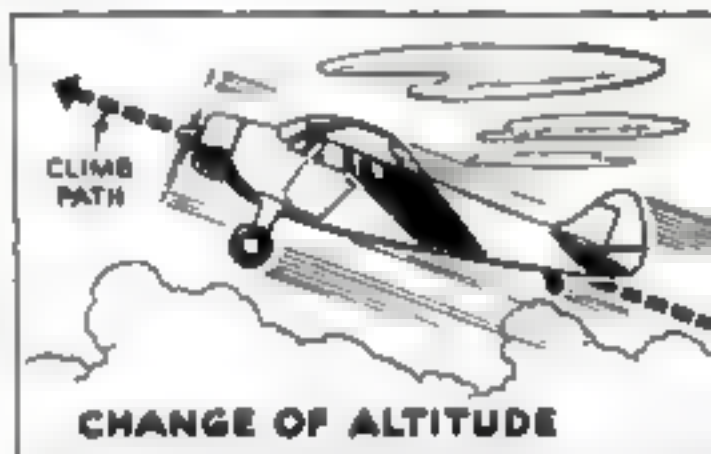
After flight speed is reached in a ground run under propeller pull, tail is lowered to increase wing angle of attack and lift plane

With blades set flat, main rotor is speeded up. Then the pitch of the rotor blades is increased to lift the craft straight upward



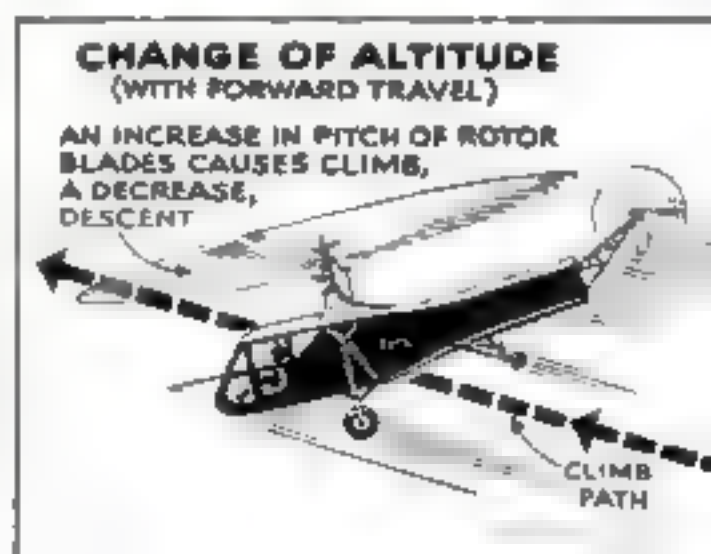
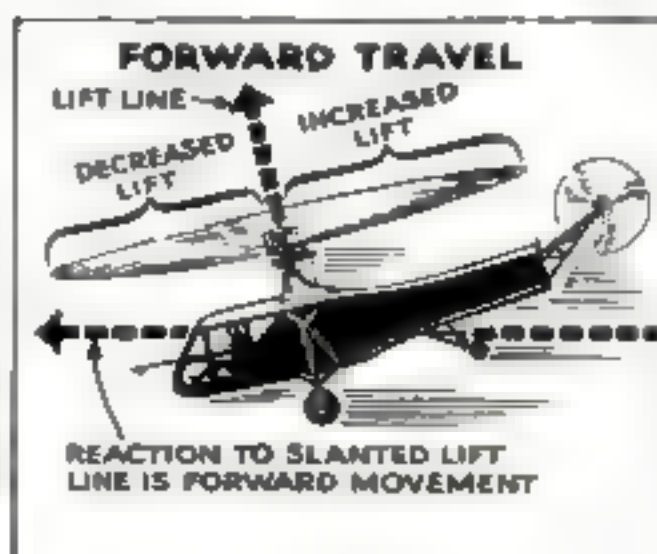
Engine power acting directly through the propeller pulls the plane forward. Speed is changed by altering engine speed or changing prop-blade pitch

Cyclic blade-pitch change causes the rotor's plane to slant forward, pulling the ship ahead. Small tail rotor-counteracts torque of big "windmill"



Elevators lower tail and increase wing attack angle. Opening throttle supplies power for lift. When elevators are lowered, tail rises and the plane descends

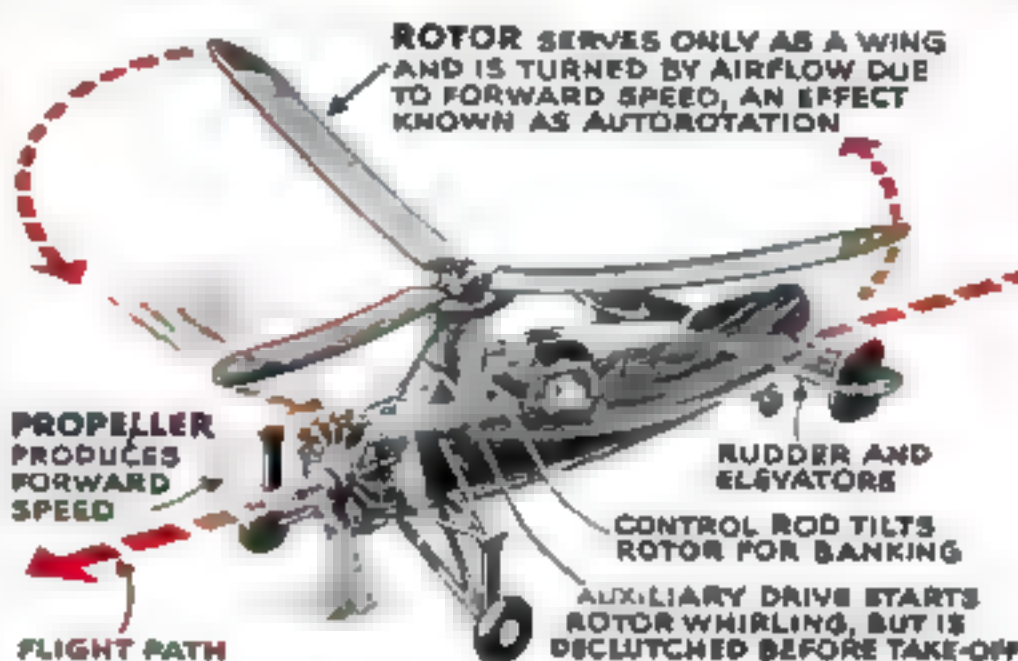
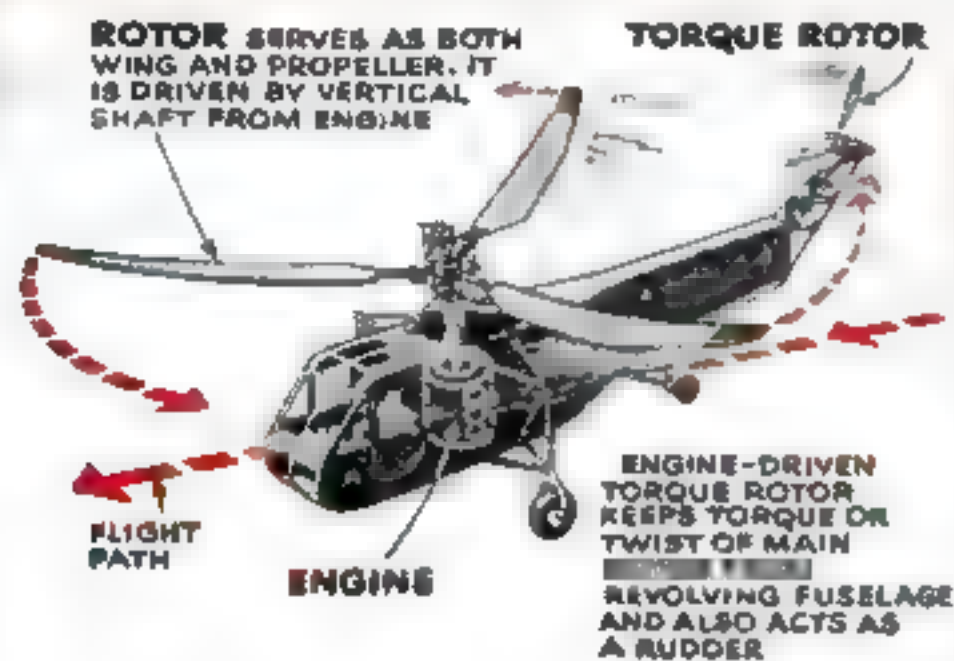
To climb, pitch angle of rotor blades is increased uniformly and throttle is opened. Flattening the blade pitch and closing throttle gives gradual descent



THE HELICOPTER VS. THE AUTOGIRO

Because its engine power is applied directly to the rotor, it can rise and descend vertically or hover practically motionless in the air. By inclining the craft (or, in other types, by tilting the rotor shaft) the pilot can cause it to move forward, backward, or sideways as he may desire

Like the fixed-wing airplane, it depends on forward motion for its lift. Therefore, it cannot rise or descend vertically, though it is capable of steeper take-off and climb than the conventional aircraft. Short take-off and landing runs are possible. It cannot hover except when headed into a brisk wind



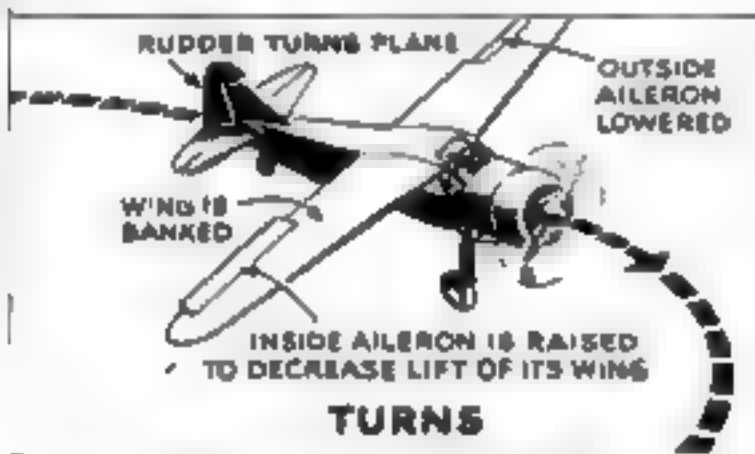
gigs that have been publicized for two years as the answer to the common man's desire to fly. Their faults are manifold. Many thousands of engineering hours must be put in on them before the ultimate consumer can buy them, in a manner of speaking, across the counter.

Potentially, the helicopter is the ideal flying machine for millions who otherwise

never would fly. For the moment it is trickier, actually harder to fly, than a conventional airplane. It is far less stable. It is far more dangerous in the hands of a butter-fingered novice. It is related of Charles A. Lindbergh that he made three attempts to pilot the Sikorsky helicopter and succeeded only after thinking the problem out.

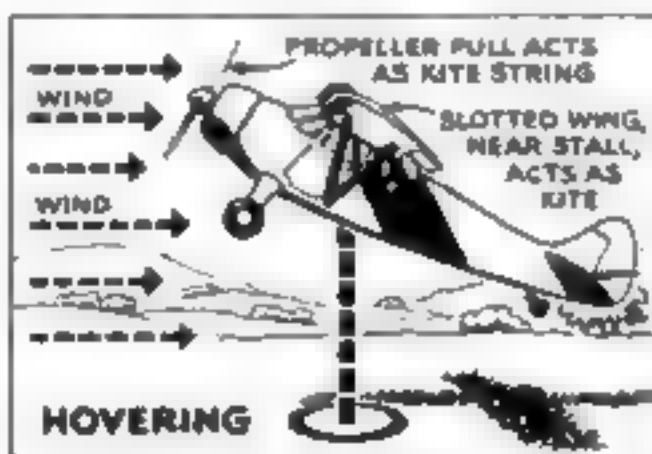
Competent engineers say it will be at

IN PERFORMING THE BASIC MANEUVERS OF FLIGHT



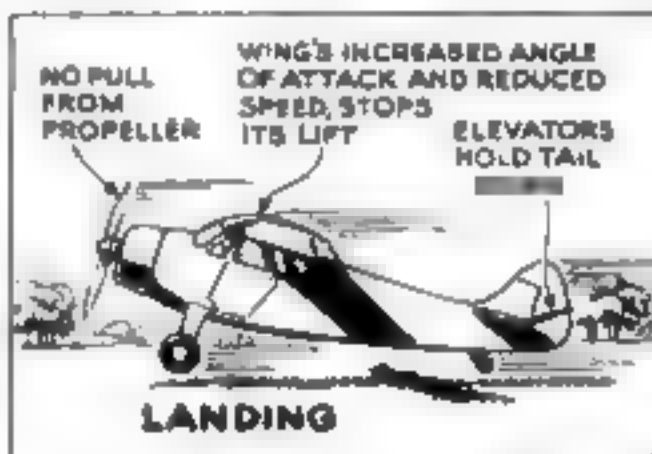
Ailerons raise outside and lower inside wing to bank plane for turn and prevent skidding. Rudder swings the tail around to bring the plane onto desired course

Bank is produced by increasing pitch of rotor blades in the portion of arc on outside of turn. Pitch of torque-rotor blades is changed to swing tail around.



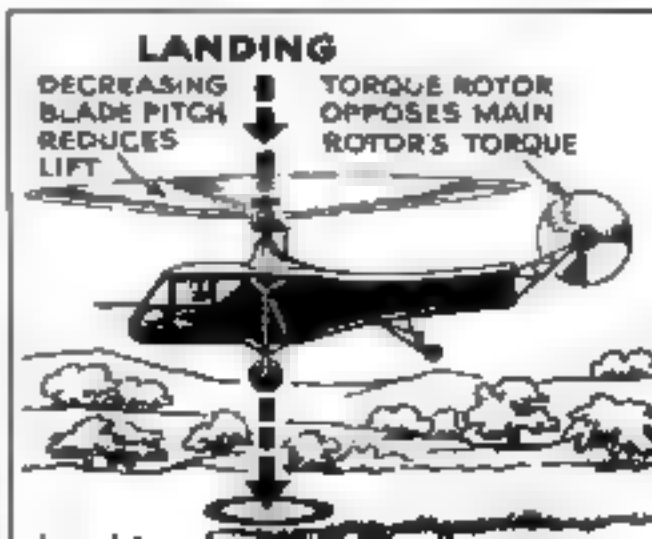
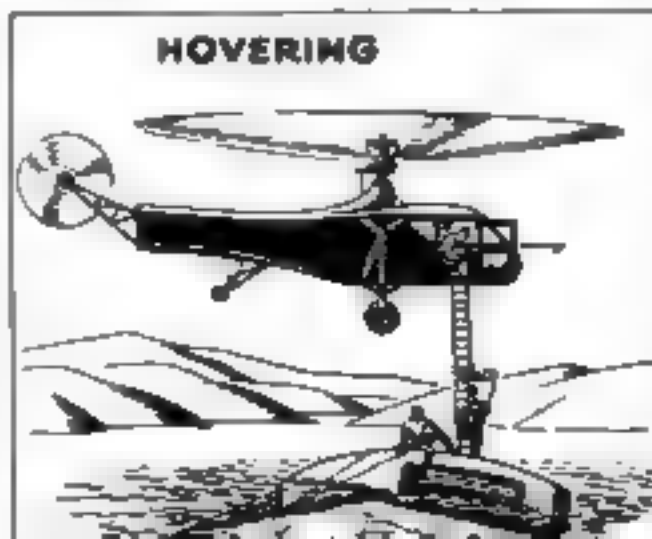
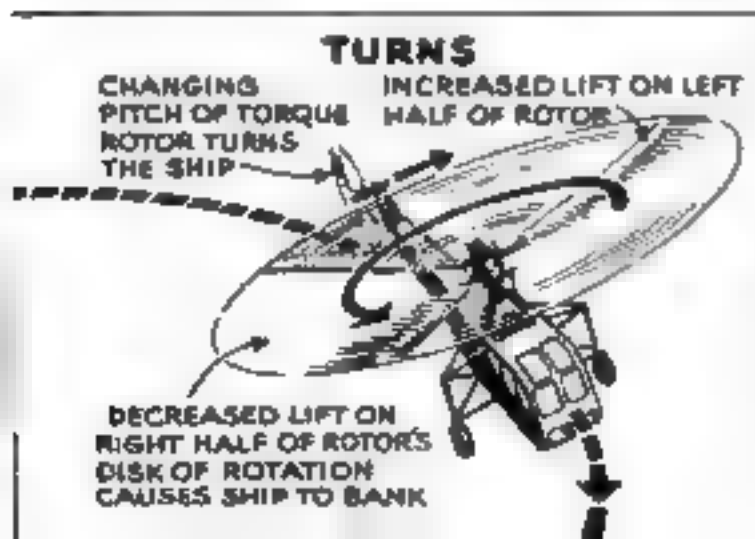
Some planes are capable of something close to hovering when flying against a strong breeze in a nearly stalled attitude—a risky maneuver

By adjusting the common pitch control so that the main rotor lifts enough to support the ship, the helicopter can be kept nearly motionless



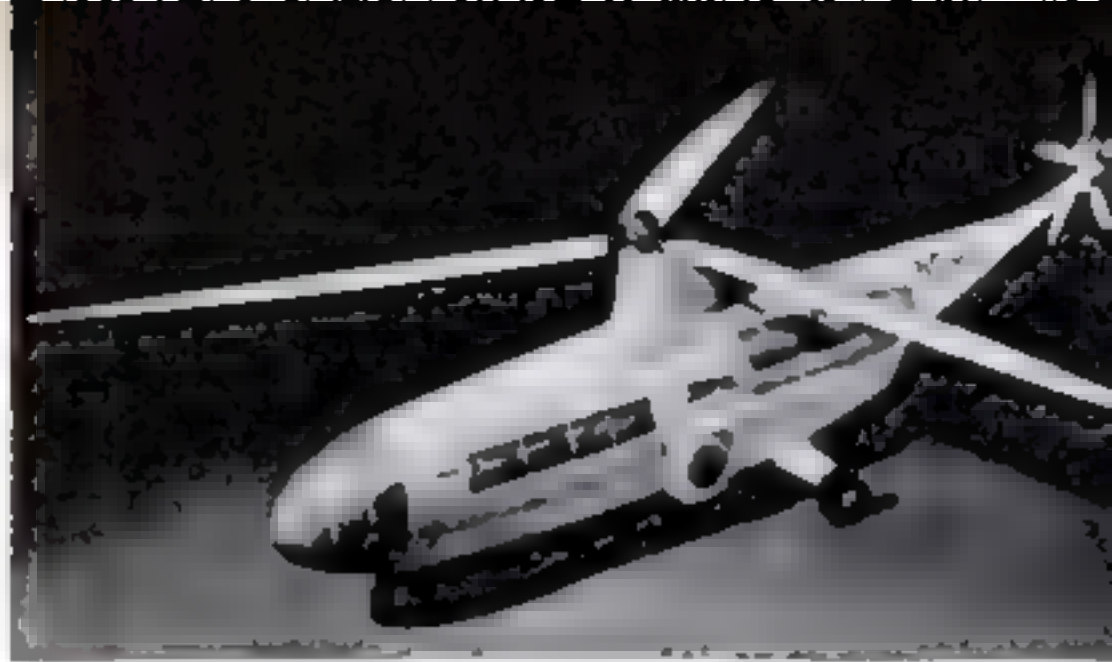
With engine throttled down, the plane skims the ground until its flying speed is lost. Then tail is lowered just before contact

Helicopter hovers over desired landing place. Then the pitch of the main rotor blades is decreased, and the craft settles





MILITARY usefulness of the helicopter is due to its ability to hover for observation and reconnaissance. This float-equipped model is landing on the deck of a ship in a demonstration of its value as a submarine spotter for guarding vessels in convoy



COMMERCIAL possibilities are foreshadowed by this model of an aerial bus designed by Raymond Loewy in collaboration with Igor Sikorsky. It would carry 14 passengers. Grayhound Bus Lines have applied for permission to operate such craft on 49,130 miles of routes

least five years—possibly 10—after the war ends before the consumer helicopter, resplendent in its chrome fittings and its mohair interiors, takes its place alongside the motor cars of Automobile Row on thousands of American Main Streets. Intensive, war-born engineering may, of course, better those figures.

To understand why the helicopter embodies such iridescent possibilities and yet in operation and safety is so complicated and at such a disadvantage with conventional aircraft is to understand first what makes it work. The name itself describes the plane's operation. Helicopter comes from the Greek words *helix* or *helikos*, meaning spiral, and *pteron*, meaning wing.

It affords a brand-new way to fly. There is nothing like it in the whole, vast field of aeronautics. Flying machines roughly can be lumped into two categories—those that are aerostatic, or lighter than air, like the free balloon, the powered blimp, and the

rigid-framework dirigible; and those that are aerodynamic, or heavier than air, like the airplane, the Autogiro, the ornithopter, and the helicopter.

Among the aerodynamic aircraft the airplane has been, of course, the most successful. No successful ornithopter—which is supposed to sustain itself in the air by flapping its wings—ever has been built, in spite of many attempts.

Autogiros and helicopters fly for the same reason that fixed-wing airplanes fly. Just as the propeller attached to the front of a fixed-wing airplane consists of a group of elongated airfoils rooted to a hub, so the lifting surfaces of Autogiros and helicopters consist of two or more long wings with an extremely small width, or chord. The only difference between the fixed-wing airplane and the Autogiro and helicopter lies, substantially, in the method of inducing lift. The airplane obtains it through the forward velocity of the entire aircraft. The

HELICOPTER'S HISTORY IS A SERIES OF ATTEMPTS

"HELICOGYRE" built by Raoul Pescara and tested at Barcelona, Spain, in 1920, had two coaxially set four-bladed rotors with biplane vanes. Counter-rotation neutralized torque. The machine rose from the ground, but lacked controllability for practical use

CURTISS-WRIGHT helicopter, designed by a company engineer in 1929, was a complicated affair with a four-bladed propeller set in the leading edge of each "wing" and a stabilizing airfoil behind. After a few trial flights the novel design was abandoned

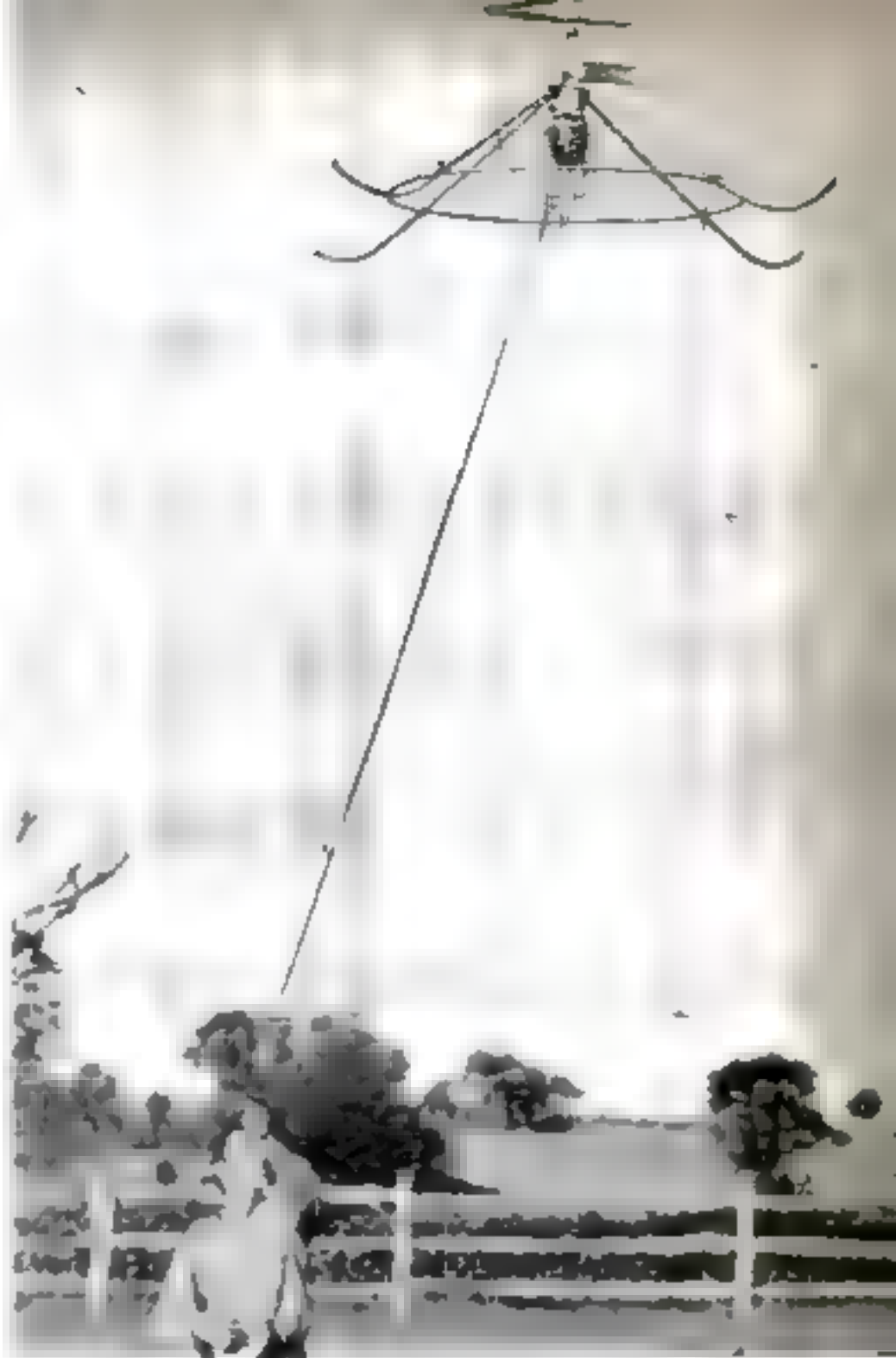


Autogiro and helicopter obtain it by substituting for forward velocity the rotating velocity of their elongated wings operating in a horizontal plane above the fuselage

While these two have in common the ability to fly because their wings rotate and induce lift, most of the similarity ends there. The wings of the Autogiro auto-rotate. They are free-wheeling. The wings of the helicopter auto-rotate only in the event of an engine failure, for safe descent. The Autogiro's wings are actuated by the stream of air flowing against and around them owing to the forward motion of the aircraft or to descent. In other words, the Autogiro must have a means of forward propulsion. It mounts a conventional engine and propeller on the nose. By contrast, the only means that the helicopter has of attaining horizontal velocity is its collection of overhead blades, or rotor.

The power in the engine of the helicopter is applied, of course, directly to the rotor. Flight forward, backward, or sideways is achieved in one of two ways: by tilting the entire rotor assembly in the direction of the proposed line of flight, or by changing the pitch of the blades in opposite quadrants of the circle they describe in their trip around the hub at 200 to 250 times a minute. The latter system is termed "cyclic pitch control" by Dr. Igor I. Sikorsky, engineering manager of the Sikorsky Division, United Aircraft Corporation, manufacturer of helicopters for the Army.

In helicopters with tiltable rotor heads the plane of rotor rotation is inclined a couple of degrees toward the vertical, thereby drawing both lifting and propulsive energy from the blades. In helicopters with cyclic pitch control, the effect is the same but it is achieved different- *(Continued on page 206)*



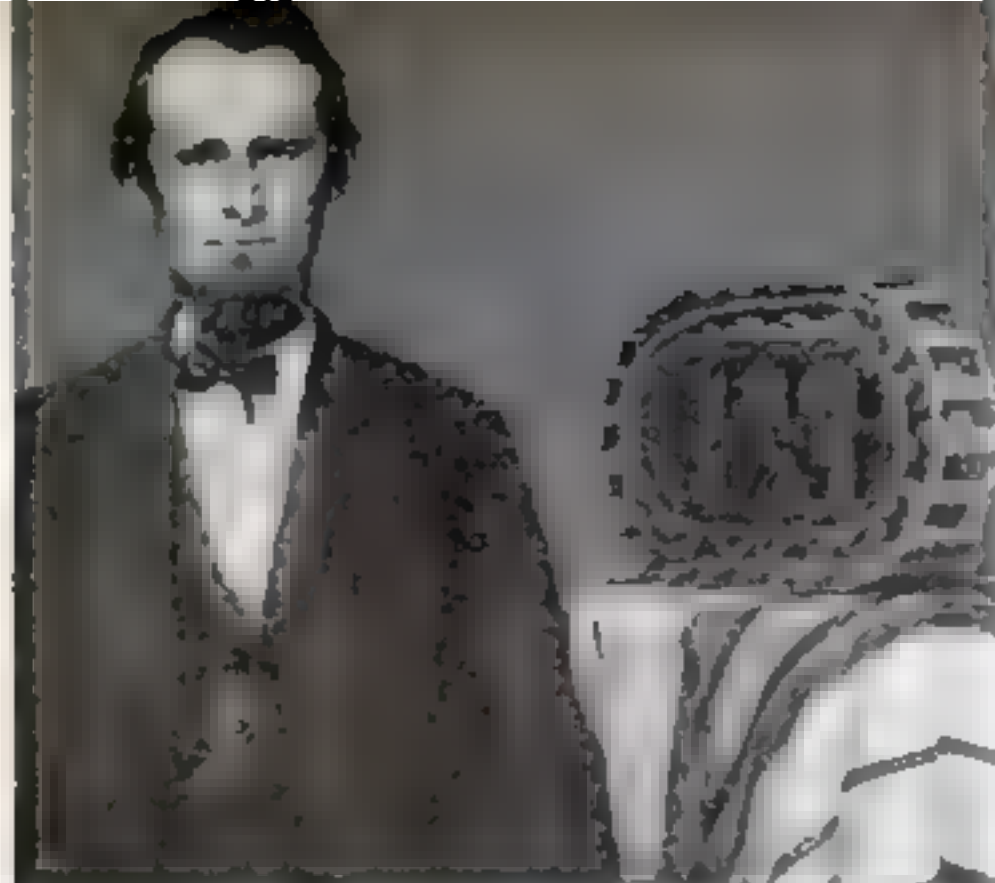
EXPERIMENTAL helicopter built by Arthur M. Young, designer of the Bell helicopter, for testing various types of blades. Its two-bladed main rotor is driven by a vacuum-cleaner motor powered through a cable which serves as a kite string, and controlled by a rheostat worn on the "pilot's" chest. A stationary vane beneath the rotor counteracts torque. When motor speed is reduced, the odd "kite" descends slowly and settles onto the ground

TO OVERCOME PROBLEMS OF ROTATING-WING FLIGHT

DE BOTHEZAT conducted experiments in direct-lift flight for the U. S. Army at Wright Field, Dayton, Ohio, in 1922. His machine, typified by the model shown below, had four large rotors mounted on the ends of a cross-shaped tubular frame. Lateral motion was supposed to be obtained by speeding up one of the four windmills

SIKORSKY made the first successfully controlled flight in his V5-300. While getting the feel of this new aircraft, he tethered himself to the ground with a cable, flew a little higher each time





THE MAN WHO PIONEERED for the tank and the tractor was Henry T. Stith, who, 71 years ago, made the model with which he is shown. His patent of seven years later is reproduced at the right. Besides being an ingenious mechanic and inventor, Stith was a clever ventriloquist and a successful Kansas farmer

The Tank Tread Was His Baby

But he invented it away back in the '70's before the internal-combustion engine and tractor had been developed. First applications were to a streetcar and his son's bicycle.

SEVENTY-ONE years ago this summer, a Kansas farmer patented a wheel that carried its own track. This was an idea comparable to the invention of the chariot. Placing soldiers on wheels made blitz attacks possible; providing them with caterpillar treads has empowered them to go anywhere, with heavy guns and armor. But, like the inventor of the chariot, the Kansas farmer-inventor has been forgotten.

He was Henry T. Stith, a Civil War veteran and a ventriloquist and sleight-of-hand performer as well as a Kansas pioneer and ingenious mechanic. He put his track-totting wheel assembly on a horse-drawn streetcar and exhibited it at a Kansas City fair in 1879. He also built a crawler tread for his son's bicycle.

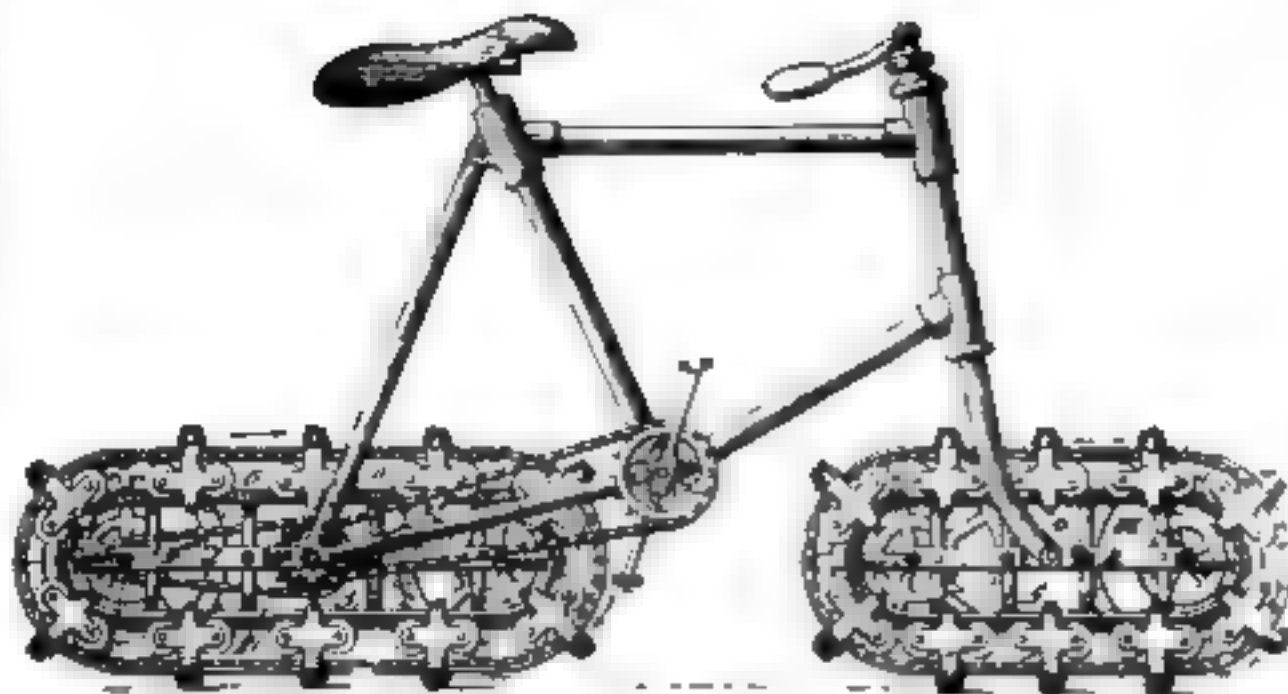
But Stith had his big idea too soon. He designed his first "elliptical wheel with an endless supporting track" three years before the granddaddy of the modern automotive gasoline engine was built. And his new kind of wheel was not widely appre-

ciated until the internal-combustion engine had been perfected.

In 1904, when Stith was 65 years old, Benjamin Holt, a California tractor manufacturer, designed a sectional, track-laying wheel that was used on farm machinery. And in 1916, the year after Stith died, the British started the first tanks rumbling across no man's land in France. Such traction has since caused revolutionary changes in both agriculture and warfare.

Many of the big prime movers of the world's armies travel now on caterpillar treads. They have made possible such feats as the rapid clearing of jungles for airports, the tapping of new resources in Russia, and the quick construction of the Alaska highway. Countless hours of labor have been saved by these big machines. A sure-footed bulldozer is likely to be the first vehicle ashore in every invasion now. And machines that carry their own tracks can move heavy guns across soft, sandy shores and over hitherto impassable roads, despite a hail of bullets, to shove cannon on self-propelled mounts right up to the foe's nose.

Moving tracks similar to those that Stith built long ago not only compensate for unevenness of the ground, as he intended, but also make it possible for a mighty machine to walk nearly as lightly as a man. The pressure on the ground from a 30-ton caterpillar tank is less than 13 pounds per square inch. And a tank, gripping the earth with many cleats, can roll through muck and mire in which ordinary wheels would spin and sink.



HE TRIED IT ON A BICYCLE

WORSE THINGS can happen to a boy than being an inventor's son. Stith fitted his lad's bicycle (patent drawing at left) with a crawler tread when U. S. Grant was U. S. President. Even with its speed limitations, it would still be the envy of every war-conscious boy in the neighborhood

Henry Stith did not foresee all the uses to which the world has put such an improvement on wheels. But he turned down \$50,000 for the rights to the brightly painted red-and-yellow Patent Traction Street Railway that he took to a fair, because he thought it was worth millions. It was his favorite among his many inventions.

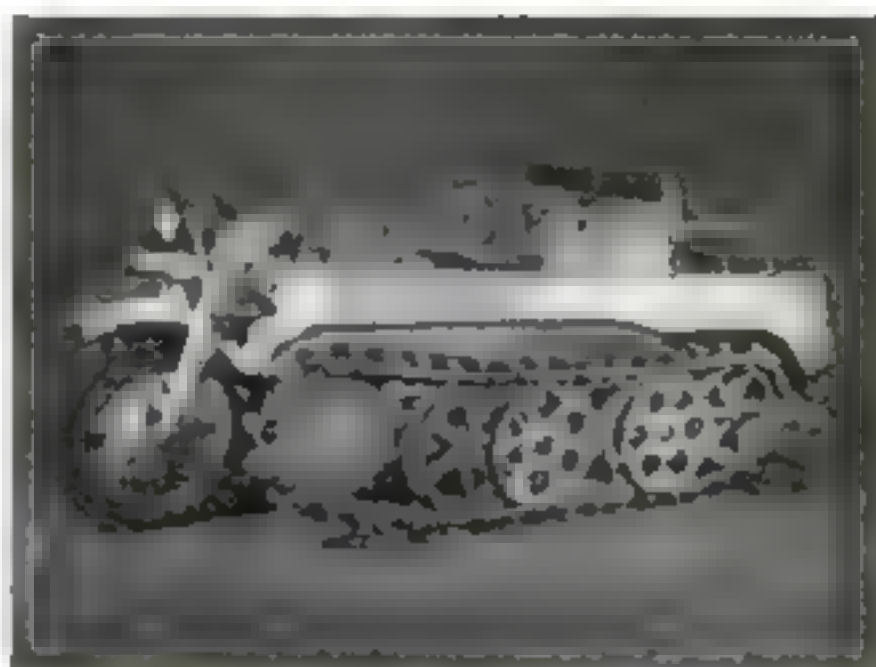
As a boy, born in Tennessee in 1839 and growing up near Springfield, Ill., he had learned ventriloquism. To enlarge his repertoire as an entertainer, he then began inventing sleight-of-hand tricks. He continued to perfect such tricks and give shows, to bolster his income in lean years, after settling down to farm near Ottawa, Kans.

Stith built a new kind of rat trap, which is still widely used, and swapped the rights to it for 120 acres of land. He also patented roller bearings, invented a puzzle-purse, and made himself a typewriter. His neighbors laughed when he sat down to type, but he wrote with his homemade machine for many years.

He patented his elliptical wheel three times; in 1873, 1880, and 1900. The last patent dealt with its application to a bicycle. (His son still has the bicycle that Stith provided with crawler traction.) But the inventor's friends discouraged him. He became engrossed in farming and was disinclined to risk more money on his elliptical wheel. And his comfortable financial condition when he died was a consequence of his acquisition of a thousand acres of farm land rather than his most portentous idea.

He thought of his invention as a contribution to constructive enterprise rather than as an aid to warfare. But his children believe that, if the use of caterpillar treads now hastens the overthrow of the foes of human progress, their father would be proud to be known as the man whose idea made tanks possible.

ON MODERN BATTLEFIELDS



TRACKED MOTORCYCLE captured from the Nazis in Africa carries a driver with two passengers or an equivalent load in light weapons or ammunition. The steering wheel can be shed in swampy terrain

LUSTY GRANDCHILD of Stith's invention of a lifetime ago is this tank of World War II—the fire-belching, hard-hitting mobile fortress that is manned by modern American rough riders



Locust Killers Fight Famine

ARMY WITHOUT GUNS WAGES WAR OF EXTERMINATION TO RESCUE CROPS FROM ANCIENT BIBLICAL PLAGUE

BRITISH troops, 1,000 strong, are spreading arsenic in Arabia this year to combat one of mankind's oldest and fiercest foes. This expedition, traveling in 330 motor vehicles, carries no guns, for it is operating in a neutral land by agreement with King Ibn Saud of Saudi Arabia. Its purpose is to prevent a plague.

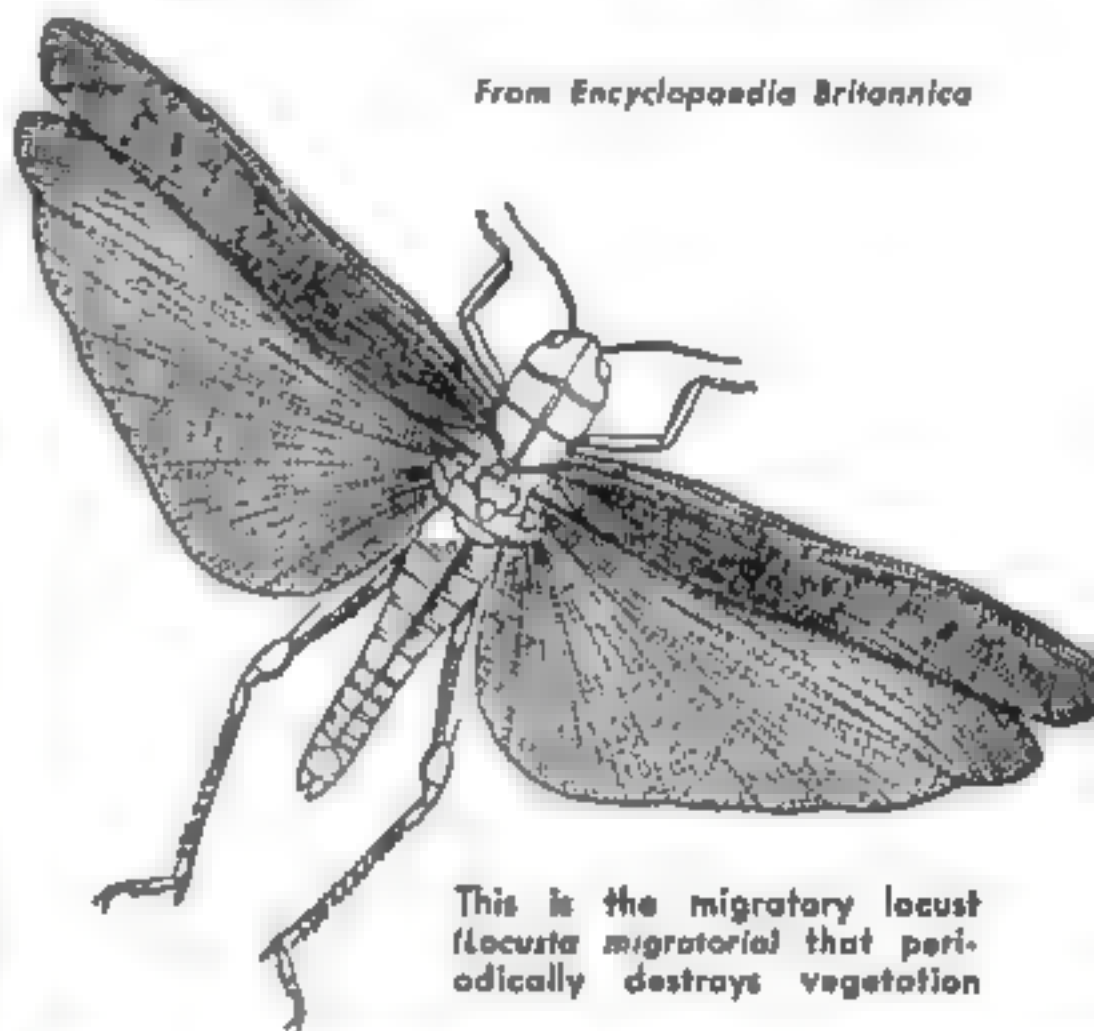
Locusts such as in Biblical times "covered the face of the whole earth, so that the land was darkened" hatch in the Middle East. Entomologists have found that great clouds of these insects are especially likely to swarm into Europe and destroy crops every twelfth year. This is the twelfth year. Poisonous bait is being spread, therefore, in the breeding grounds of the pests and across their migration path.

An army of these 'hoppers' has been known to cover 2,000 square miles. A

traveler between Moscow and the Crimea once found the ground so covered with locusts for 400 miles that driving over them was like crossing freshly plowed earth. They have penetrated as far as Northern Scotland. Any such attack by the insects now would magnify the problem of feeding people freed from the Nazis.

United Nations experts hope, however, to wipe out nine-tenths of the migratory locusts in their infancy by carefully spreading an arsenic compound mixed with moist bran. The anti-locust research center in

From Encyclopædia Britannica



This is the migratory locust (*Locusta migratoria*) that periodically destroys vegetation



Maj. W. H. Pickavance commands one of the British locust-killing units. His white kafiyah (headcloth) marks him as an officer

Some of the 330 motor vehicles of the expedition drawn up before the start of the 3,000-mile trek. Because Saudi Arabia is neutral the men of the British task force carried no arms, wore Arab headdress





Dusting poison over the terrain from an airplane is one of the methods of coping with the problem. These men are loading up in preparation for a raid on potential crop destroyers

A flanking movement by the fighters spreads poison bait in the line of locusts' advance. These "booby traps" exterminate millions



London is providing scientific direction, under Dr. Uvarov, who is called the world's greatest expert on locusts. An American major, J. M. McGough, is also going along.

Its personnel includes many civilian technicians and Arabs, whose transportation and supplies are being provided by the British Army. One group's route is across Palestine, Syria, and Iraq to the head of the Persian Gulf, then down through Saudi Arabia; another group has been assigned to cross the Sinai desert and proceed down Arabia's west coast.

Since this campaign is expected to be a nine months' job, involving more than 3,000 miles' travel over roadless territory scarcely ever visited by white men, members of the expedition were chosen after physical tests as rigorous as those for paratroops. Besides jeeps and other vehicles, the expedition has seven radio-transmitting stations and 18 receiving sets. It also carries nine phonographs with records, footballs, boxing gloves, darts, indoor games, and a library. For the Arab personnel, special books and records in their own language are provided. The expedition is taking along an immense supply of stores, including medical supplies, gasoline and water containers, and spare parts enough for at least eight months.

No military badges are worn, but officers

are distinguished by their Arab headgear. Their *kafiyas* (square cloths worn over the head like handkerchiefs) are white, and their *egals* (headbands) are gold. Other ranks wear red-and-white *kafiyas* and black *egals*. Owing to the shortage of water and the custom of the country, authorization of the wearing of beards seemed probable.

No alcohol could be taken along, because Saudi Arabia is the Holy Land of the Moslems, who are teetotalers, but each group took 500,000 cigarettes. Army catering cooks and a butcher accompanied the anti-insect troops, prepared to supplement canned rations with sheep and other food bought en route. Purchases were arranged by an advance man who flew over the locust breeding grounds. The money he carried had to be chosen carefully, however, because the Arabs there value a coin bearing a man's head more highly than one showing a woman's head.



Blue Monday during the African campaign was brightened by ingenious Yankee soldiers who built this effective motor-driven washing machine out of makeshift materials. Among the parts were a gasoline drum, a motorcycle engine, and paddles cut from the armor plate of a luckless Nazi plane

Ingenuity Is Their Middle Name

Natural-born inventors, the Yanks improvise the comforts of home and the necessities of war.

By JOHN (TEX) O'REILLY

Veteran War Correspondent

THAT mixture of ingenuity and mechanical ability which is so deeply ingrained in American boys is now being manifested on fighting fronts in a great many parts of the world. Wherever American soldiers show up, they astound, amuse, and confuse the native population with an assortment of makeshift gadgets, some of which would

make a Rube Goldberg creation seem downright simple.

I'm not talking about the regular equipment of the American Army—that is considered superb the world over. I refer to the thousand and one devices that any group of American soldiers will originate to increase their comfort or amuse themselves. These may range from a simple way of heating water for shaving to an improvised welding machine.

Some of these creations may look silly, but most of them work. The practice that American soldiers got as boys, when they experimented with farm machinery, repaired the family car, or spent hours in the basement workshop, is now standing them in good stead. Turn a bunch of American soldiers loose in a wartime scrap heap, and no-



THIS DESERT ARC WELDER IS A HYBRID

After blowing down on plane, ground crew men in the Sahara assembled this welding outfit, mostly from materials unwittingly furnished by the enemy. Even the throttle control came from a wrecked plane.

**RADIATOR
FROM GERMAN
JEEP**

**BELTS BOUGHT
FROM TRACTOR
DEALER**

**ENGINE FROM
ITALIAN JEEP**

**GENERATOR FROM
WRECKED AXIS
AIRPLANE**

body can predict what will come out of it. You may not be able to tell what it is until you see it work, but it will have a function, and the chances are that it will be built in something like record time.

One afternoon I was sitting in the officers' tent of an American fighter squadron in Libya. Bad weather kept the planes grounded. It was rainy and miserable. A cold wind whipped across the desert. The pilots sat in the tent with their flying jackets on and tried to hold magazines with numb fingers. On the whole, it was a cheerless gathering, but there was nothing else to do. The major commanding the squadron sent for a sergeant.

"Sergeant," he said, "we're freezing to death in here. How about a stove?"

"Yes, sir," said the sergeant. "I'll see what I can do."

With that he went out of the tent. I wondered where on earth he expected to get a stove. Beyond

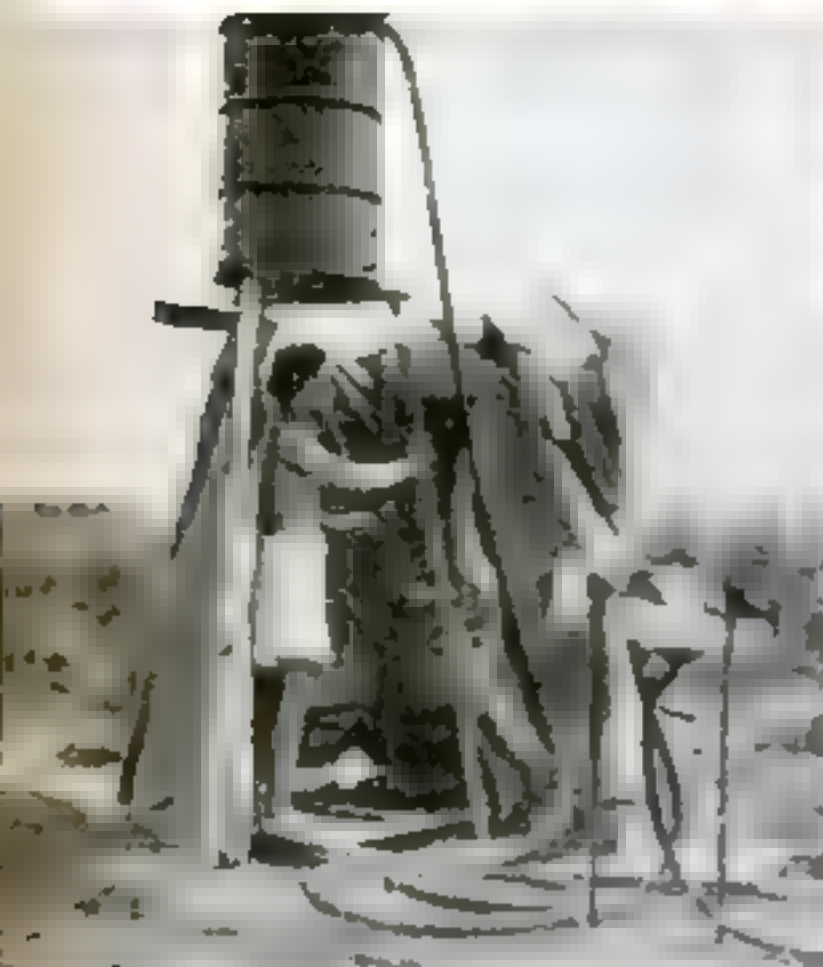
our field there was nothing but desert for hundreds of miles. Fat chance he'd have of getting a stove anywhere in this bleak country. You might as well look for an ice-box in an Eskimo village.

Two hours later, a private came into the chilly tent carrying four rocks, which he placed in a square on the ground in a corner



At one of the African bases the kitchen utensils for the squadron failed to arrive, so the men went to work and fashioned a set, making use of aluminum from Axis planes shot down in raids on their bivouac area. The soldier in the foreground is frying bacon in a camp-made skillet over a portable vapor stove

URGE FOR CLEANLINESS AND COMFORT



One of the dozens of uses to which the versatile gasoline drum is put by service men. Atop a simple six-foot scaffold, with little else than a length of rubber hose, it serves as a shower bath for tired, dusty soldiers



The urge to look spruce prompted this resourceful Yank to heat the bottom section of his mess kit and use it as a flatiron for pressing his trousers. He may have got the idea from the old Chinese ironing implement, which is made of brass and contains a hollow space on top in which live coals are placed to keep it hot

of the tent. "What's that for?" asked a pilot.

"Base for the stove, sir," was the answer. The words were no sooner out of his mouth than two other privates came into the tent carrying a large stove. They were followed by the sergeant with the stovepipe. The stove was set up on the rocks, and a hole was cut in the side of the tent for the pipe. The stove itself consisted of a German gasoline drum picked up on the desert. These American gadgeteers had also obtained a small tank, which was attached by an iron brace to the side of the drum. A piece of metal tubing with a valve salvaged from a wrecked German plane led from the tank

into the drum. The tank was filled with old engine oil drained from the planes. To make the stovepipe, they had cut the tops and bottoms from British gasoline tins and soldered them together. This pipe, after proper adjustment, stuck out of the side of the tent at a rakish angle.

A layer of sand—there was plenty around—was placed in the bottom of the stove and another rock was put on top of that. The sergeant turned the valve. Black oil began to drop on the rock. The sergeant touched a match to it and it broke into flame. In a short time the interior of the tent was warm. Conversation increased with the

BUT WAR NEEDS GET PRIORITY



Skilled and resourceful mechanics are constantly proving their worth among the American fighting forces as they battle on their way to Berlin and Tokyo. Even at temporary bases, the workbench is a vital item in the equipment of our mechanized Army. No less important is the Yanks' ingenuity in creating, repairing, and reassembling new machinery from old parts and makeshift materials. Wartime scrap heaps, fragments of shot-down planes, abandoned tanks and cars furnish these men with hundreds of parts that can be turned to account when regular supplies are either delayed en route or destroyed

INSPIRES MOST IDEAS

warmth. The pilots drew their benches up around the stove. Somebody propped open the door at the bottom so they could watch the fire. For the first time that tent on the dreary desert had a cheery note. It wasn't like home, but the burning oil crackling on the rock at least brought the feeling of an open hearth. Incidentally, that sergeant is now a lieutenant.

Knowledge of automobiles and what makes them run helps American soldiers to solve their personal transportation problems. In territory that has recently been captured from the enemy, they may be seen riding in or on a weird assortment of vehicles. In Africa they would find motorcycles, cars, or trucks abandoned by the Germans or Italians because they (the vehicles) wouldn't run. After some tinkering, stripping down, and reconnecting, the Americans would have them rolling again. I once saw an American soldier popping along over the desert on an Italian motorcycle that seemed to be defying all mechanical principles. To me it appeared as if at least a third of the essential parts were missing. It looked like the skeleton of a motorcycle, but it was getting him over the ground.

Americans also are tickled pink when they can get hold of a German jeep. The German jeep, or *Volkswagen*, is pretty tinny and can't compare with the American jeep, but it's fun to putter around with one.

When our troops first arrived in Africa, their eagerness to tinker with and make use of abandoned enemy planes and vehicles sometimes got them into trouble. The Germans would leave them behind with booby traps hidden in them. On one occasion the first American to get to an abandoned plane on a captured field looked in and saw a nice battery inside. It was just what he wanted to rig up an electric light for his tent. He tore the wires off of it and carried it away. Other Americans climbed in and started manipulating the controls. Later, 13 booby traps were found in the plane—but they had all been wired to the battery. Luckily, when the first soldier jerked off the wires, he had disconnected the whole setup. Americans have learned their lesson. Now they approach abandoned vehicles and planes with extreme caution until they are sure they have not been booby-trapped.

Sometimes the devices soldiers think up are extremely simple when seen in use, but somebody had to think of them first. If a man wanted to shave in the western desert, he took one of the British gasoline tins that littered the landscape, and cut out the top. Then he would cut a hole in the side for a draft. Several inches of sand would be placed in the bottom of the can and saturated with gaso- *(Continued on page 218)*



Another version of the improvised gasoline-drum washing machine. Men who never gave a thought to the laundry problem at home give much attention to it in the field. Cleanliness is one of the major concerns of the American soldier and he copes with it often and successfully.

A New York lad wearing a French beret can't wait for the washing machine, so he boils his clothes in a dehydrated-potato tin over a fireplace built of rocks collected in the vicinity of the camp where his own outfit is stationed.



This young man will consider carefully before returning to the United States during the next six or seven months. It is leap year and he has demonstrated his skill as a handyman in both the making and using of a washing machine.



ON THEIR WAY— A Better Life Promised by War Inventions

By
HAL BORLAND

Drawings by ABBOTT GRIFFIN

LONG before the postwar political problems are settled, long before the dream cars are on the road, or the helicopters are in the back yards, you and I and everybody else will be living healthier, safer, more pleasant lives. And all because war has so greatly magnified the hazards of disease and discomfort.

All over the world, scientists on war assignments have been fighting a little-noticed but all-important battle against sunburn, frostbite, mosquitoes, flies, lice, seasickness, contaminated water, and a thousand other

maladies and irritations that lessen the fighting man's efficiency. They have succeeded in that battle to a remarkable degree, and when peace comes we are all going to benefit.

Take the matter of seasickness. A troublesome annoyance in peacetime, it became a critical problem when great forces were massed offshore for invasion. But out of insistent research came the Army's "pink pill," which is more effective than anybody had dared to hope. Its basis is atropine, a drug extracted from belladonna, and prostigmine, a synthetic drug used in treating muscular disease. The pink pill is also effective against airsickness, an important point when we think of the vastly expanded air-transport and passenger service just ahead.

When men faced flame throwers and when tanks and planes were set afire in battle, better treatment for burns was sought and found. One primary treatment sprays an emergency "skin" over the wound; another covers it with an oil-silk membrane. Both enable nature to make quick repairs and both minimize scarring.

In battle and in industry, chapped skin and more serious skin troubles, caused by oils and acids as well as weather, had to be remedied. New antiseptics were compounded in salves and ointments which all of us will soon be using.

Frostbite has always been a problem in arctic weather. The Russians came up with the best solution—a salve which not only protects toes and fingers from the cold but enables a mechanic to work on a gun, tank, or plane at 35 below zero without seeing his flesh peel off onto the icy metal. In-

With Peace Will Come These Aids to

HEALTH



CLOTHES



SOAP



Sunburn, which annually takes a gigantic toll in pain and absenteeism, will lose its sting under the salves and lotions that have been developed to protect those of our troops who fight under scorching sunlight.

New methods of weaving GI clothes so as to make them more durable, and of laundering them so as to make them waterproof, will be available to civilians when peace comes.

Headed for eventual use in our homes is an all-around soap that lathers quickly in cold or hard water and that is now being employed by our soldiers for bathing, shaving, and washing clothes.



Lighted gas range, open window, curtains flapping in the breeze, ... in the old days, this would have been an invitation to fire. But a new du Pont preparation makes the fabric fire-resistant

In place of rotten, nylon strips will be woven to form the seats and backs of light summer chairs. The material is smooth, easy to clean, highly weather-resistant, and extremely tough. Its coloring will not fade in rain or sunlight



Ingredients of this salve are still undisclosed, but it will be available to the public after the war.

Athlete's foot has plagued homes, gymnasiums, swimming pools, and barracks for a great many years. Its cure came from researchers seeking inhibitors for mold in bread, and mildew in fabrics. The inhibitors they found—one with a complex or-

ganomercurial base, another with a sodium-propionate base also checked the fungus which causes athlete's foot. The sodium-propionate method also cures ringworm of the scalp and skin, thrush, blacktongue, and ear infections caused by fungus

Dysentery and other digestive ailments were conquered by a multipurpose germicide which releases active chlorine. It

Safer and More Comfortable Living

SPORTS



The small collapsible boats which are now used by forced-down airmen, and which can be tucked away in the back of a car, will come as a long-awaited boon to the vacationing fisherman and duck hunter

FOOD



Due to arrive in the housewife's kitchen is a glass, flameless stove that—like the metal-treating induction furnaces in our war plants—cooks by means of cold heat

TRAVEL



Civilian motorists will get better mileage and more trouble-free operation from their cars with the high-octane gasoline now being produced for use in tanks and planes. Cars will embody many war improvements



A new chemical known as "DDT," which can be dusted on the body without injury to the skin, is protecting our soldiers from the maddening irritation of body lice. After the war, this insecticide will be used as a sterilizer in sickrooms and hospitals

sterilizes dishes and utensils even in cold water, and will have wide use wherever there is sickness. In tablet form, this same compound effectively sterilizes drinking water. A tablet or two in a canteen makes swamp or creek water fit to drink.

Vermin, particularly those which spread disease, are being wiped out in the Army's "delousing bags." A soldier simply puts his clothes or bedding into a special bag, tosses in an ampoule of methyl bromide, and half an hour later the whole bundle is sterilized. This will greatly simplify hospital and sickroom problems after the war.

Another type of vermin treatment is a powerful chemical repellent—DDT, or dichloro-diphenyl-trichloro-ethane—which is dusted or soaked into the clothing. When applied, it protects the wearer for at least a month. It is particularly effective against typhus-bearing lice.

In footwear, the Army has found that a new type of shoe sole made entirely from reclaimed rubber gives four times the wear of ordinary leather or composition soles. The cost is low and this sole is certain to find wide use, particularly on work shoes.

Although the idea is not wholly new, the Army's development of "layered" clothing for cold climates has produced the best all-around outfit yet designed. It includes woolen underwear and shirt, pile-fabric jacket, lined and unlined trousers, various types of jackets, and

parka. All are loose-fitting, tight only at wrists and ankles, and may be worn in almost any combination.

Step over now into the field of sport, play, and travel and you will find a similarly wide range of new development.

For the fisherman there are several types of collapsible boats, compact enough to be tucked away into an odd corner of an automobile—or an airplane—yet sturdy enough to weather an ocean storm. You'll see a lot of them on lakes and streams in the days ahead.

For hunters and hikers, as well as fishermen and campers, there is a whole assortment of new condensed foods—dried, powdered, concentrated, or tinned. Many of them go into emergency rations now, but before long you'll find these same items in hikers' knapsacks.

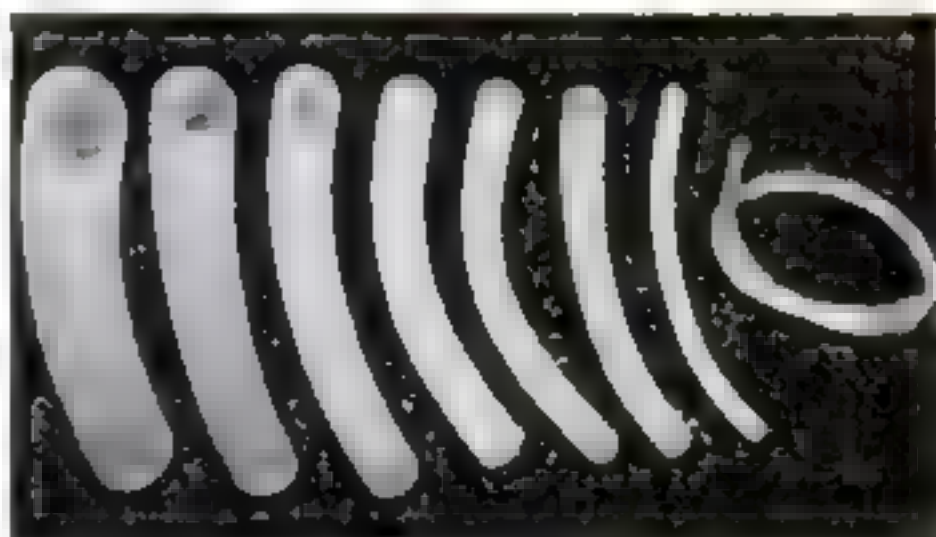
Mountain and desert travelers undoubtedly will have in their first-aid kits a set of the new hypodermic injectors (P.S.M., April '44, p. 122), with antivenom for snake bites. This injector consists of a sealed ampoule connected by a plastic tube to a needle. To use it, one inserts the end of the needle into the skin, then bends the plastic tube, thus breaking the ampoule seal and automatically forcing the ampoule's contents into the muscle or vein. Our jungle fighters are using this equipment right now.

For tenderfoot land travelers, there will be better gasoline than ever before. It probably will be higher octane than our prewar gasoline, and it certainly will be a more satisfac- *(Continued on page 200)*



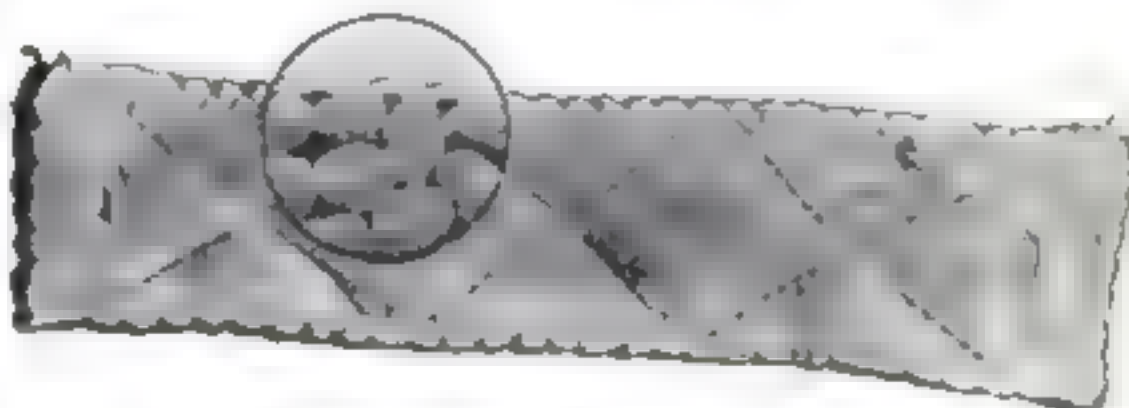
Contrast painting, which now enables workers to distinguish quickly various parts of a machine, will find a wide variety of valuable uses in the homes of tomorrow—as a complement to the highly improved systems of lighting that have also been developed in our war plants

PLASTIC PAPER printing plates recently developed for offset work will, it is claimed, save war metals formerly considered necessary, besides effecting economies in initial costs, handling expense (because of greatly lessened weight), and storage space. This invention, by William C. Toland and Ellis Bassiat of the Plastolith Company, Boston, Mass., consists of paper sheets permanently bonded together and covered outside with waterproof Plaskon resin glue. When the printing side is coated with three layers of a special alcohol-and-clay emulsion, the plate is ready for the usual engraving process. Almost any paper mill, it is said, can manufacture such plates with existing machinery. Adjustment on press is shown below.

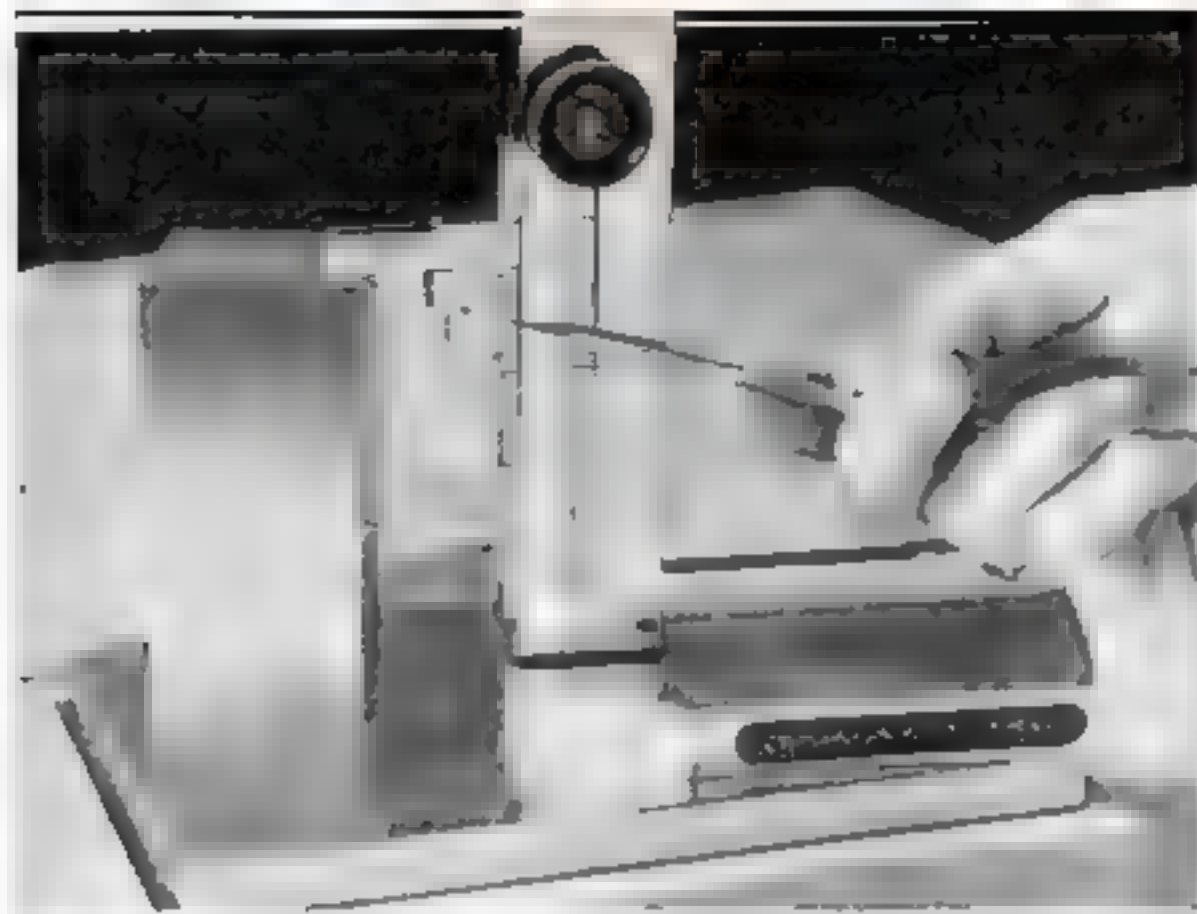


FLEXIBLE, TRANSPARENT TUBING (shown above) made of Compar, a type of vinyl resin developed by the Resistoflex Corporation, Belleville, N. J., has special advantages for laboratory use. It allows constant inspection of the contents; it is inert to almost all organic solvents; and among rubberlike materials has lowest permeability to gases.

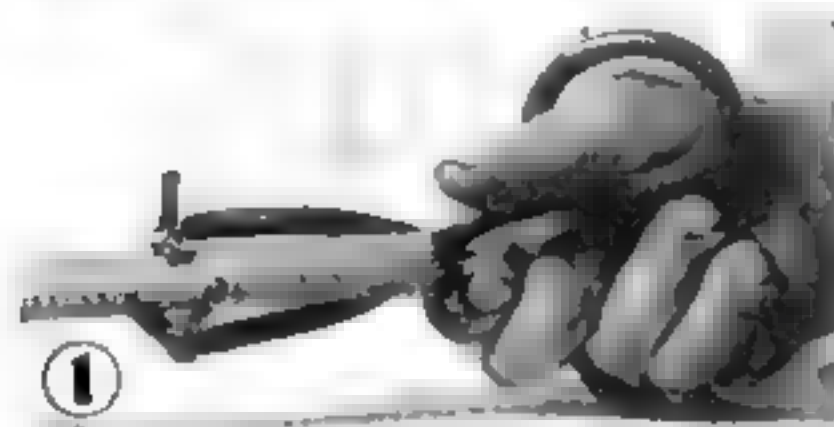
PROTECTION against shock and the chafing caused by sweat in war and civilian occupations is offered by a new type of lining for goggles, paratroopers' chin straps, and sweatbands, incorporating sponge clippings and chamois skins. The resiliency and absorbent quality of sponges and the soft texture of chamois skins combine to make a padding that contributes to safety and comfort. The oil-tanning process used for chamois prevents it from drying hard after being soaked with perspiration. Pictures at right show cut-away section of lining and its principal uses.



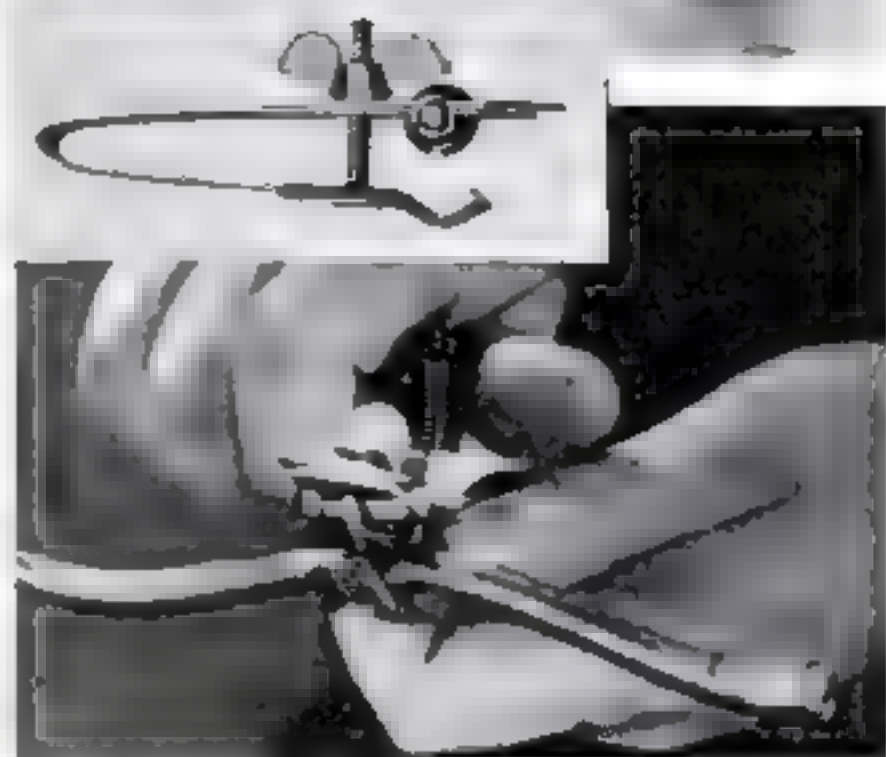
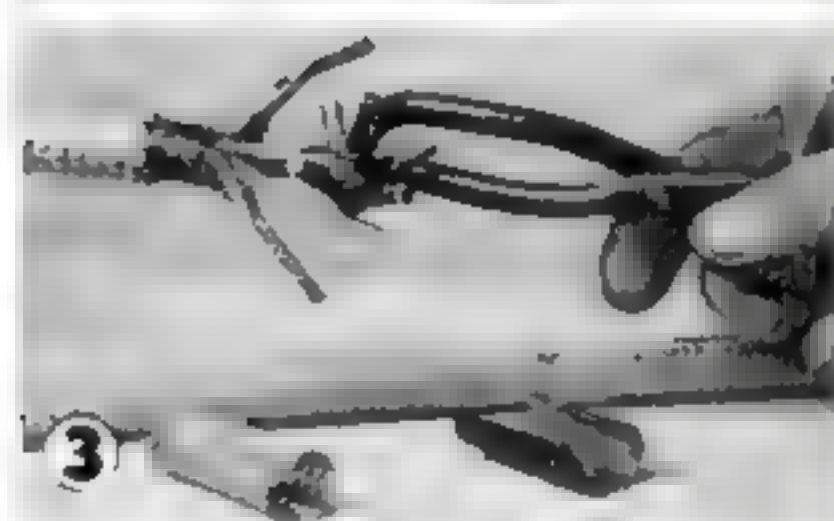
new tools



PRECISION of standard gauge blocks is increased tenfold by the DoAll Vernier Gage manufactured by Continental Machines, Minneapolis. Two blocks having a taper on their mating faces are wrung together. When one of these is moved, the change in the height of the gauge is indicated in ten-millionths of an inch by a vernier scale on the sides of the blocks.



CABLE COVERINGS of lead, rubber, or woven armor come off quickly with this combination stripper and ringer developed by E. S. Thompson, of Stockton, Calif. Photos 1 and 2 show how the tool is used to cut covering lengthwise and crosswise. Photo 3 shows how the small wires are stripped. The tool can handle wires from $\frac{1}{8}$ to $1\frac{1}{2}$ inch in diameter, and its knife can be adjusted for coverings of different thicknesses.



SPRING CUTTING is the secret of this ingenious nipper (right), which can slice copper, brass, or lead pipe $\frac{1}{8}$ to $\frac{5}{8}$ of an inch in diameter. As the tightly fastened cutter is turned around the pipe, its circular knife, forced inward by spring tension, cuts deeper and deeper until it finally severs the pipe. Manufacturer is New Britain Machine Co., New Britain, Conn.

You'll Like the Road Ahead


Say goodbye to traffic jams, red lights, and highway hazards. After the war you'll skim cross-country on supersafe speedways.

By JEAN ACKERMANN

SUPERHIGHWAYS are in sight. Ten years after the war ends you'll be free to drive to 59 of 62 top-ranking U. S. cities on a ribbon-straight expressway, hitting an average of 65, and not stopping once unless you want to. Wherever you head, you'll be taking the quickest, though possibly not the shortest route, for you'll meet no stop lights,

no hairpin curves, no crossroads, and no urban traffic.

Suppose you start out from Pittsburgh for St. Louis. You'll probably go around—not through—Indianapolis and Columbus, adding a mile or two but subtracting city congestion. When you near St. Louis, without disturbing through traffic you'll ease off the highway onto a city-service road that lands you right in the part of town you're

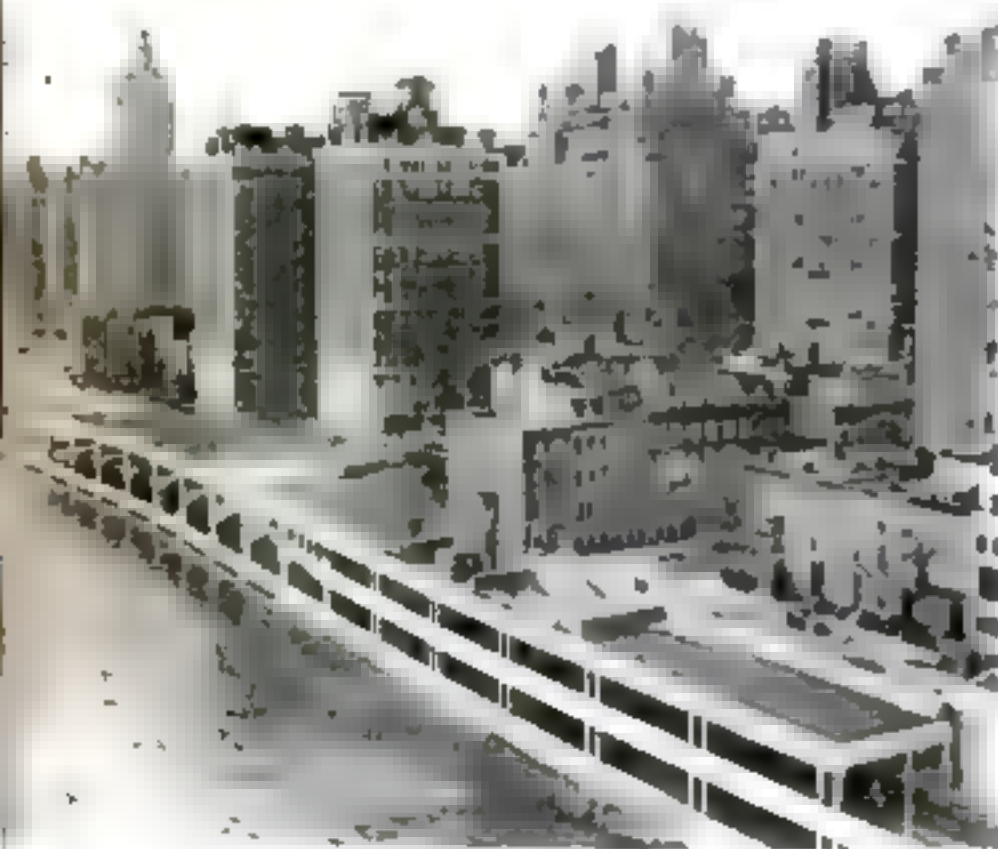
An aerial photograph of a complex highway interchange, likely the Pennsylvania Turnpike. The image shows multiple lanes of road curving and merging. A white rectangular text box is overlaid on the upper left portion of the image.

With no crossroads and only 11 interchanges (such as the one below) in all its 160 miles, the Pennsylvania Turnpike is the biggest step yet toward the ideal of "the road that drives the car."



DETROIT'S Davison Highway, which cuts a clean swath through the city by underpassing all intersections, keeps through-city traffic hustling on its way and at the same time reduces the congestion of local traffic. City-service roads cutting off the main highway lead straight into town

NEW YORK'S East River Drive was converted into a double-decker at those points where it could not be laid in regular width. Actually this is far better design, for it provides separate north and southbound traffic lanes



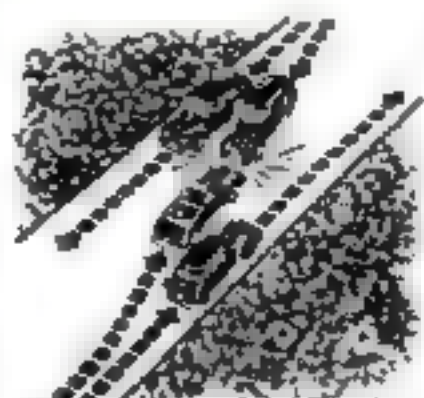
WHY ACCIDENTS HAPPEN



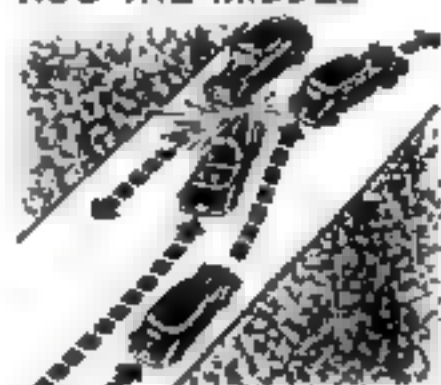
INTERSECTIONS



ROAD-EDGE HAZARDS CAUSE DRIVERS TO HUG THE MIDDLE



UNDIVIDED TWO-WAY TRAFFIC LEADS TO HEAD-ON COLLISIONS



AS DO ROADS WITH UNDIFFERENTIATED SPEED LANES

bound for. You'll have saved wear on your tires and temper, as well as considerable gas.

Something out of the World's Fair Futurama? Three years ago, yes—but now, reckoned in terms of geography, employment, dollars and cents, as well as traffic needs, it's ready for blueprinting as soon as state highway departments okay their sections of it. This Pittsburgh-St. Louis route is just one branch of a country-wide Inter-regional System, proposed by the President's committee of the same name in a report sent to Congress last January—a system which will neatly solve the problem of intercity connections and at the same time shrink urban traffic congestion to an all-time low.

The very fact that it's a plan should be good enough news for drivers weary of hap-

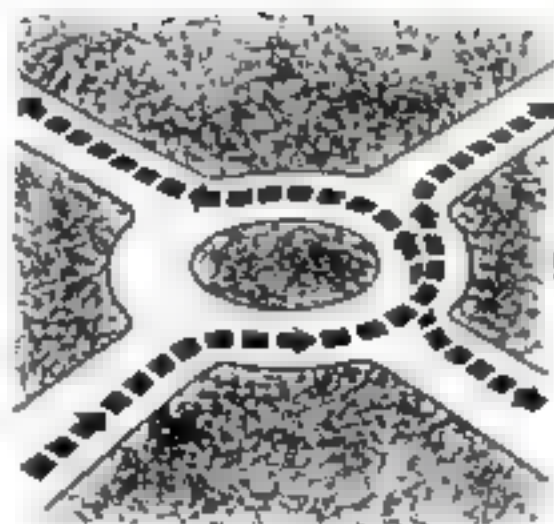
HOW HIGHWAYS HAVE BEEN DESIGNED TO AVOID THE

BAD. The least effective way of preventing head-on smashups is to have white lines running down the center of the road. Sometimes the lines are flanked by rough asphalt in a feeble attempt to keep the motorist as far from the center of the road as possible

POOR. Only slightly more successful is the dividing of the lanes with a strip of soft earth in which markers or small plants can be placed. The road below is a section of the Pennsylvania Turnpike; the road at left is a part of the Providence-Hartford highway, Route 44

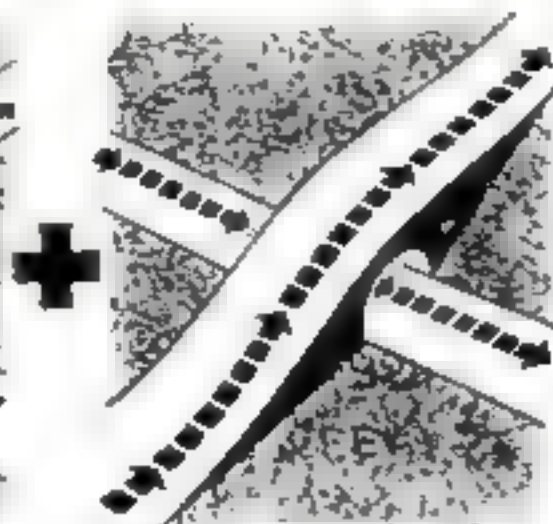


HOW ROAD DESIGN DEVELOPS ACCIDENT-FREE ROADS



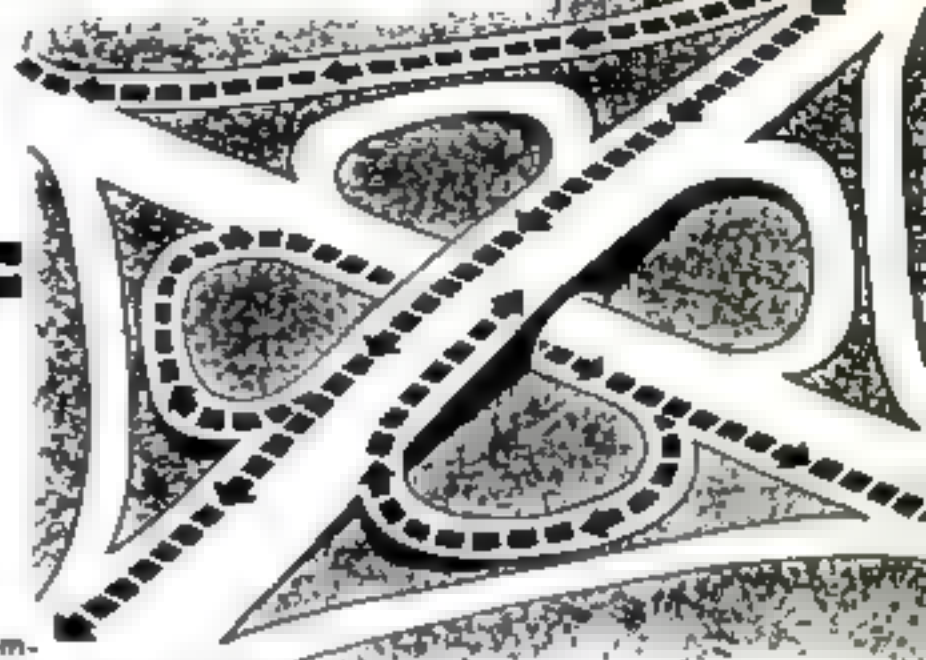
ROTARY

A rotary is designed, in part, to enable cars to pass from one road to another without stopping. At busy crossings, however, cars often get "boxed in" and find it hard to break away and leave the merry-go-round when they want to



UNDERPASS

The underpass, by completely eliminating the problem of the intersection, saves the motorists from becoming enmeshed with conflicting traffic. But it also limits the usefulness of the road by reducing the number of its entry points



CLOVERLEAF

A combination of the rotary and underpass principles makes up the cloverleaf, which preserves the virtues of each while overcoming their deficiencies. Although expensive to build, it compensates for its cost by eliminating traffic signals and patrols

hazardly built roads—one good, the next impossible. On top of this, it looks like good, sound thinking. Its excellence springs mainly from its recognition of two facts: (1) that most traffic (90 percent) starts or ends in cities, and (2) that through and local traffic can't ride comfortably together. Running between and either through or around cities, these expressways will drain off long-distance traffic, leaving byroads and urban streets free for local driving. Carefully planned and shrewdly routed for maximum service at low cost, the interregional roads, totaling only 33,920 miles, or one percent of all our streets and roads, will bear 20 percent of all the traffic in the country!

Since blueprints can be translated into construction in no time flat, work on these roads can start almost before the ink is dry

on the Axis surrender—a telling factor in the relief of immediate postwar unemployment. Such swift action, coupled with the time lag generally expected before industry can retool for civilian-car production, might produce an interesting upset of our hoary slow-road-swift-car tradition. Just as the fast Penn Turnpike of today leaves engines puffing, so the new interregional roads, some with proposed minimums of 75 m.p.h., might burn the bearings out of a '42 car (the only kind you'll be buying for the first year of peace), or even out of the new low-cost, low-speed cars that manufacturers have hinted at. In any event, car manufacturers will have a chance literally to see the lay of the land, and to retool accordingly, for part of the system should be finished after a year.

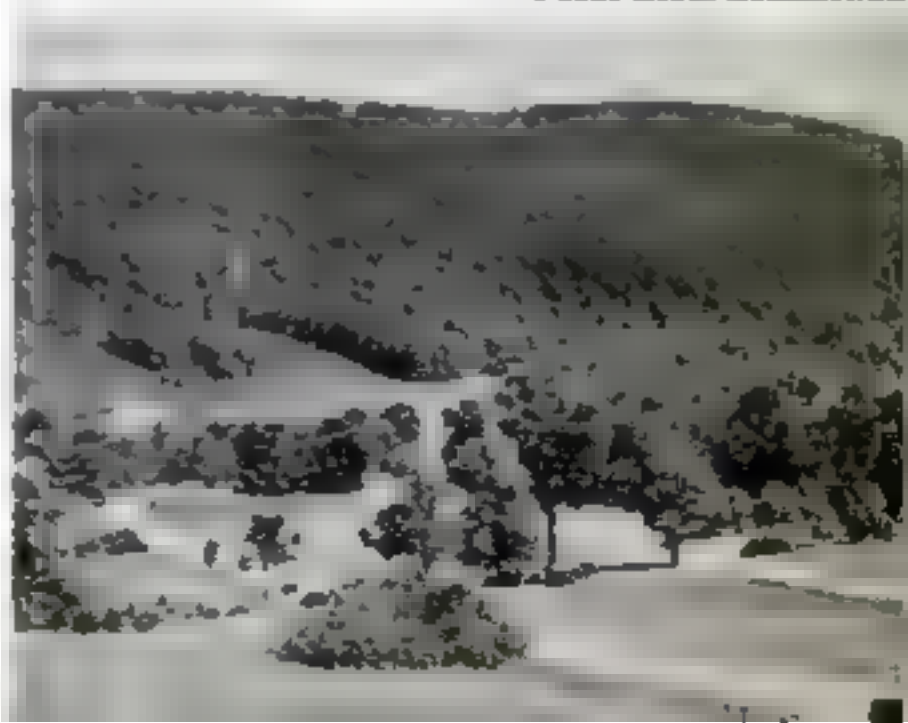
That's not quite so speedy as it sounds,

WORST DANGER OF THE ROAD—A HEAD-ON COLLISION

GOOD. Dividing highways with raised sections, however, is an excellent way of keeping cars from swerving out of line and ramming into cars coming in the opposite direction. Postwar designs have dividers four feet wide in urban areas and at least 15 feet wide in rural districts

FOOLPROOF. The best way to prevent head-smashups is, of course, the most obvious—by building separate one-way roads. The interregional highways proposed by a Presidential committee for construction after the war, will be built thus when possible

Public Roads Administration



for besides the fragments of these superways that already exist in finished form, the system will include old highways that need merely to be improved. Key motorways like the Lakefront Freeway in Cleveland, the Oakland Express Highway in St. Louis, and the East River Drive in New York City, will serve as nuclei of the network, with existing connecting roads which will be improved if they fall below set standards. Thus "building" these roads may mean large-scale revamping of some, just widening or sprucing up others, and nothing at all to advanced expressways like those listed. "Preferential improvement," that is, construction priority over nonsystem roads, will hasten the completion date. Construction, which will be state-supervised, will be paid for with funds contributed jointly by state and Federal governments.

Can a limited plan, covering only one percent of all our mileage, effect sweeping changes throughout the country? The answer is an emphatic "yes." Our roads today form a sprawling labyrinth that dates back

to the horse-and-buggy days. Horses didn't shy at curves or hills, so our dirt roads took the lines of least resistance, letting natural barriers set their course. Merchants, strong in the belief that traffic meant business, lobbied for routing these roads through the center of town, while townspeople charged that the function of roads was to link towns as well as big cities. The result is the present paradox of "through" roads that carry local traffic. The popularity of driving, causing a 1,000-percent increase in highway mileage from 1925 to 1943, and raising the cry for "more roads everywhere"—though not necessarily good ones—often led to cheap, narrow roads that are highways in name only. When Federal funds were voted for repair, either rural dirt roads got first attention, or major roads were merely repaved instead of being widened, graded, and modernized—thus preserving their infirmities in concrete.

Highway technicians tried to warn the public of the coming headache—the headache that reached the nerve-racking stage

TOMORROW'S VEHICLES WILL MATCH ITS HIGHWAYS

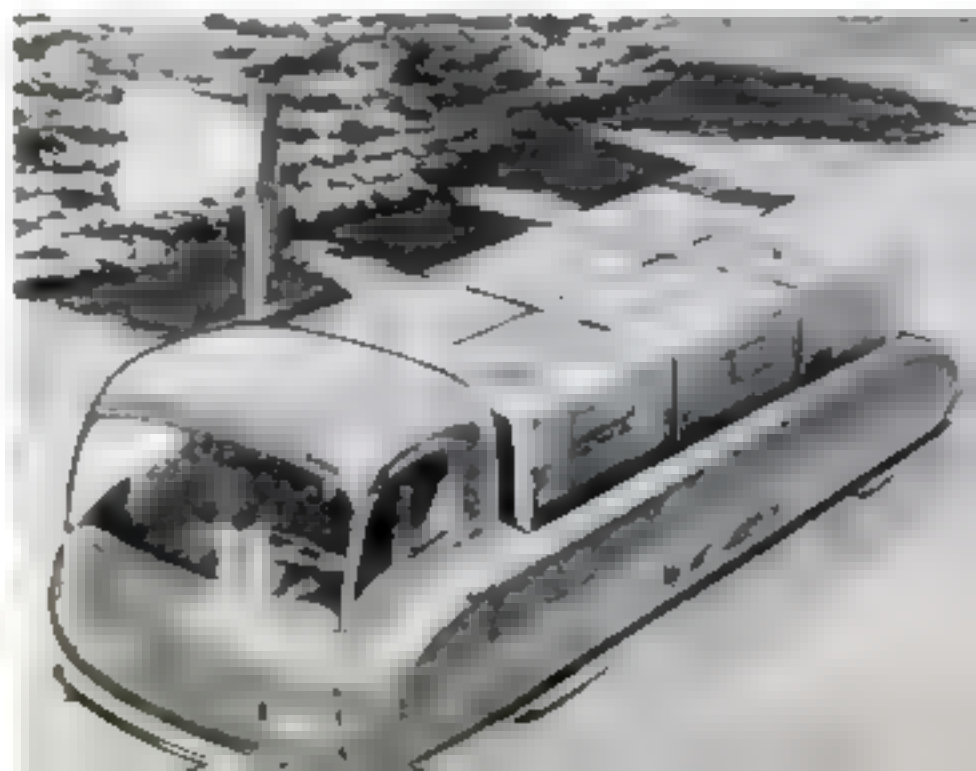
TRAFFIC CENTER. In place of the crushing masses of people and cars that now jam the main thoroughfares of our cities, Norman Bel Geddes, in his World's Fair Futurama, promised the seemingly incredible tranquillity shown below by having all vehicular traffic on one level and the entrances to buildings on a higher level, which would be reserved solely for pedestrians



Timken-Detroit Axle Co

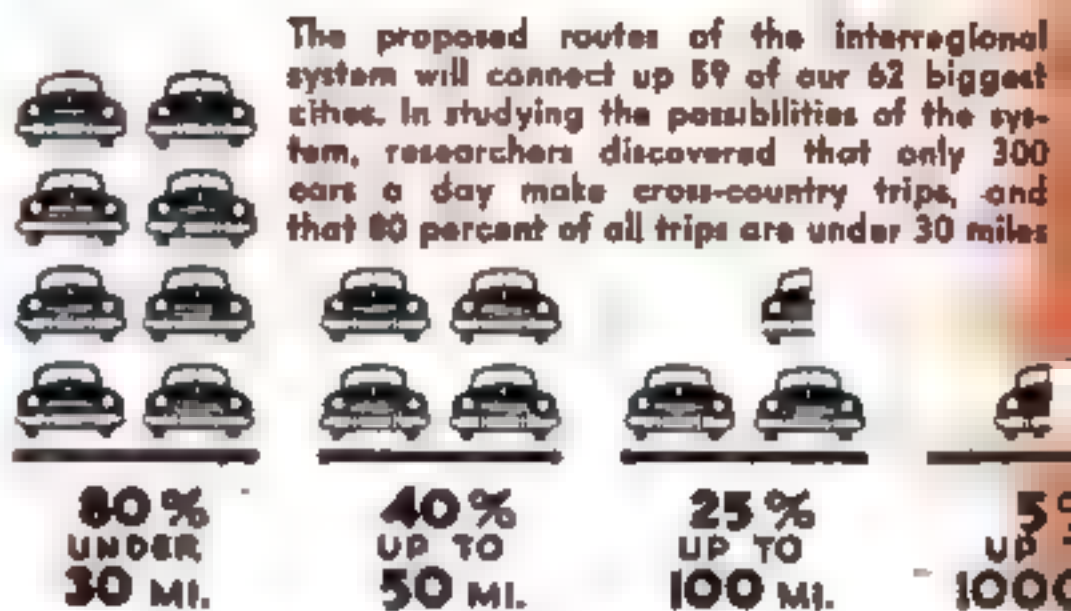
BUSES on intercity runs are destined to carry full-sized berths, bars, and observation "decks" fitted with clear-vision plastic for luxury travel

TRUCKS, light and streamlined, will transport their cargo in weight-saving plastic containers



The plan to span the Americas with one great highway will be brought nearer to reality with the construction of the U. S. interregional system. One day in the not-too-distant future a motorist will be able to follow this road all the way from Fairbanks down to Buenos Aires

HOW NEW ROADS WILL MEET DEMANDS



just before Pearl Harbor. Merchants who had schemed for town-routed highways wailed loudly when they saw trade snowed under by traffic jams outside their stores. Builders tried to cover up weak spots by installing intricate traffic systems, signs, and signals, but the job was too big for piecemeal patching. The driver suffered coming and going.

When it took an hour to creep through a fair-sized city, when Sunday trips home from the beach stretched out to Monday morning, it was finally recognized that

something was very wrong. Money-conscious legislatures began to relent. Maybe a good, wide, safe road did pay for itself. Encouraged, planners began to unfold their dreams. Some, like Norman Bel Geddes, designer of the Futurama, have suggested rebuilding cities, with separated pedestrian and motor-car levels. Others, looking for a more immediate solution, are advocating coast-to-coast and Canada-to-Mexico highways that would skim off cross-continental driving, leaving local roads and streets for local traffic. *(Continued on page 197)*

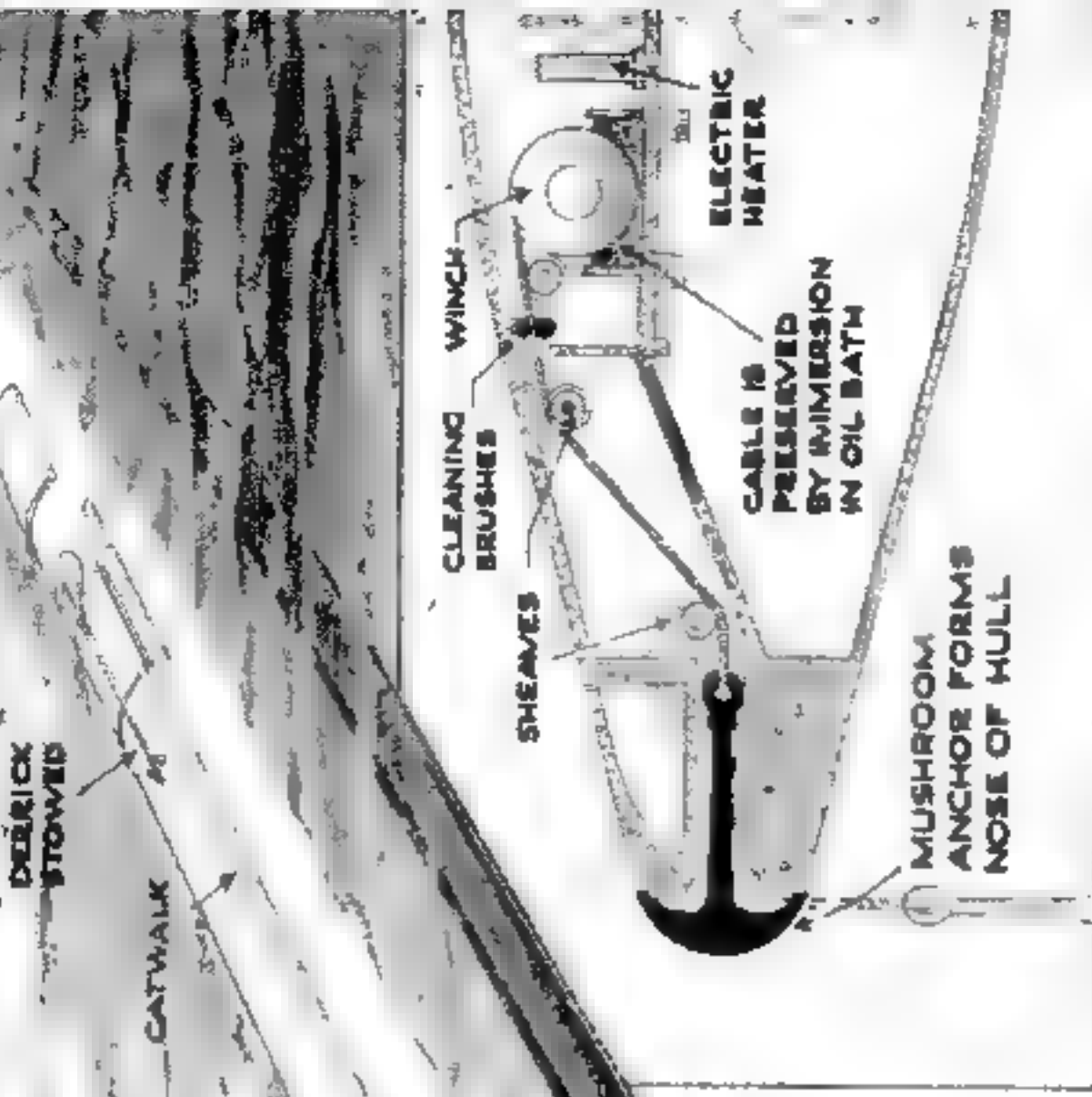
Suggested by the mats used by the Air Forces in building emergency airfields (P.S.M., Mar., '43, p. 101), steel grating, with sand and oil filling in the interstices, is now being tested as a road surfacing. Known to be nonskidding, it has still to prove its ability to maintain a smooth surface



INVENTOR NOW PROMISES 75 KNOTS FOR CONCRETE LINERS

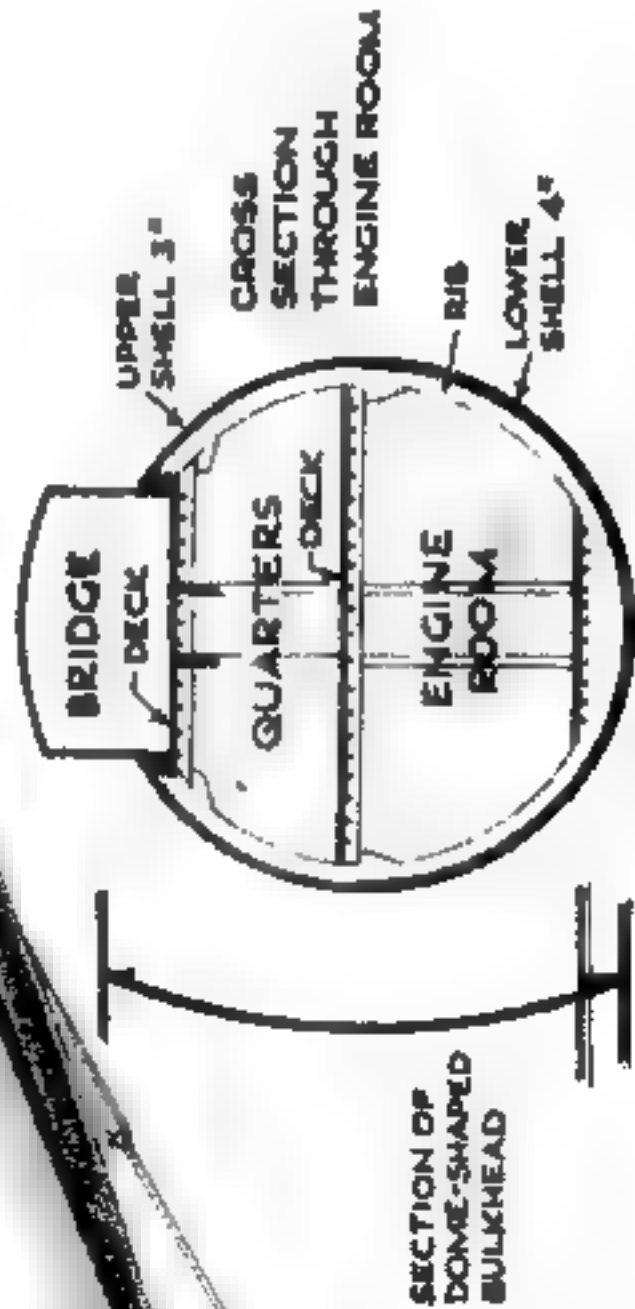
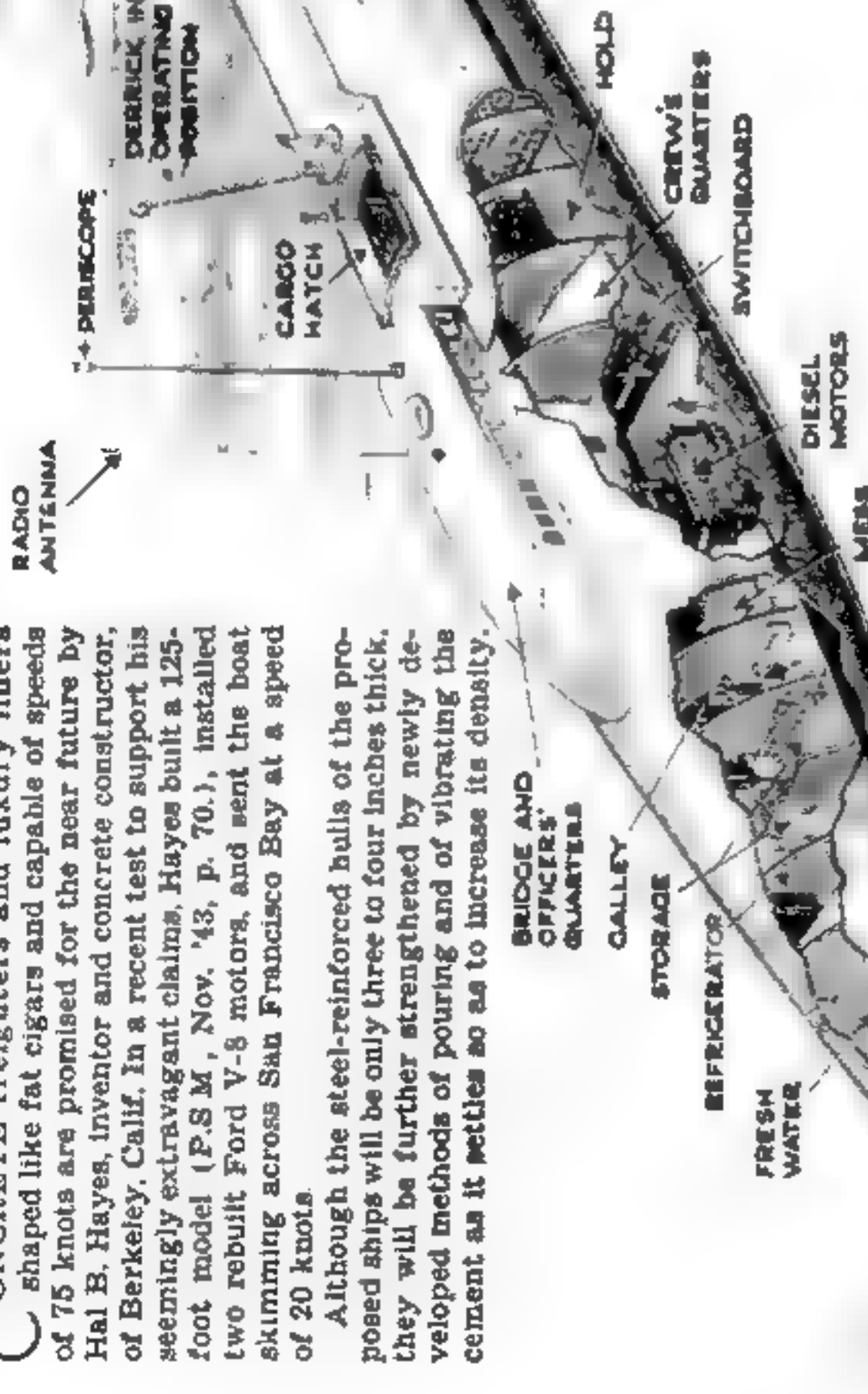
CONCRETE freighters and luxury liners shaped like fat cigars and capable of speeds of 75 knots are promised for the near future by Hal B. Hayes, inventor and concrete constructor, of Berkeley, Calif. In a recent test to support his seemingly extravagant claims, Hayes built a 125-foot model (P.S.M., Nov. '43, p. 70.), installed two rebuilt Ford V-8 motors, and sent the boat skimming across San Francisco Bay at a speed of 20 knots.

Although the steel-reinforced hulls of the proposed ships will be only three to four inches thick, they will be further strengthened by newly developed methods of pouring and of vibrating the cement as it settles so as to increase its density.



Powered by either steam or Diesel engines, the boats will lie low in the water—with a load water line of 22 feet. Yet, because of their streamlining, they will incur 27 percent less water friction than ships of conventional design. By means of simplified inner construction, the boats will be able to carry about 30 percent more cargo than Liberty freighters of equal size.

According to the designer, the ships will require only one-tenth the amount of metal that goes into an all-steel boat, and one can be built in approximately 11 days by construction crews consisting mainly of unskilled workmen.



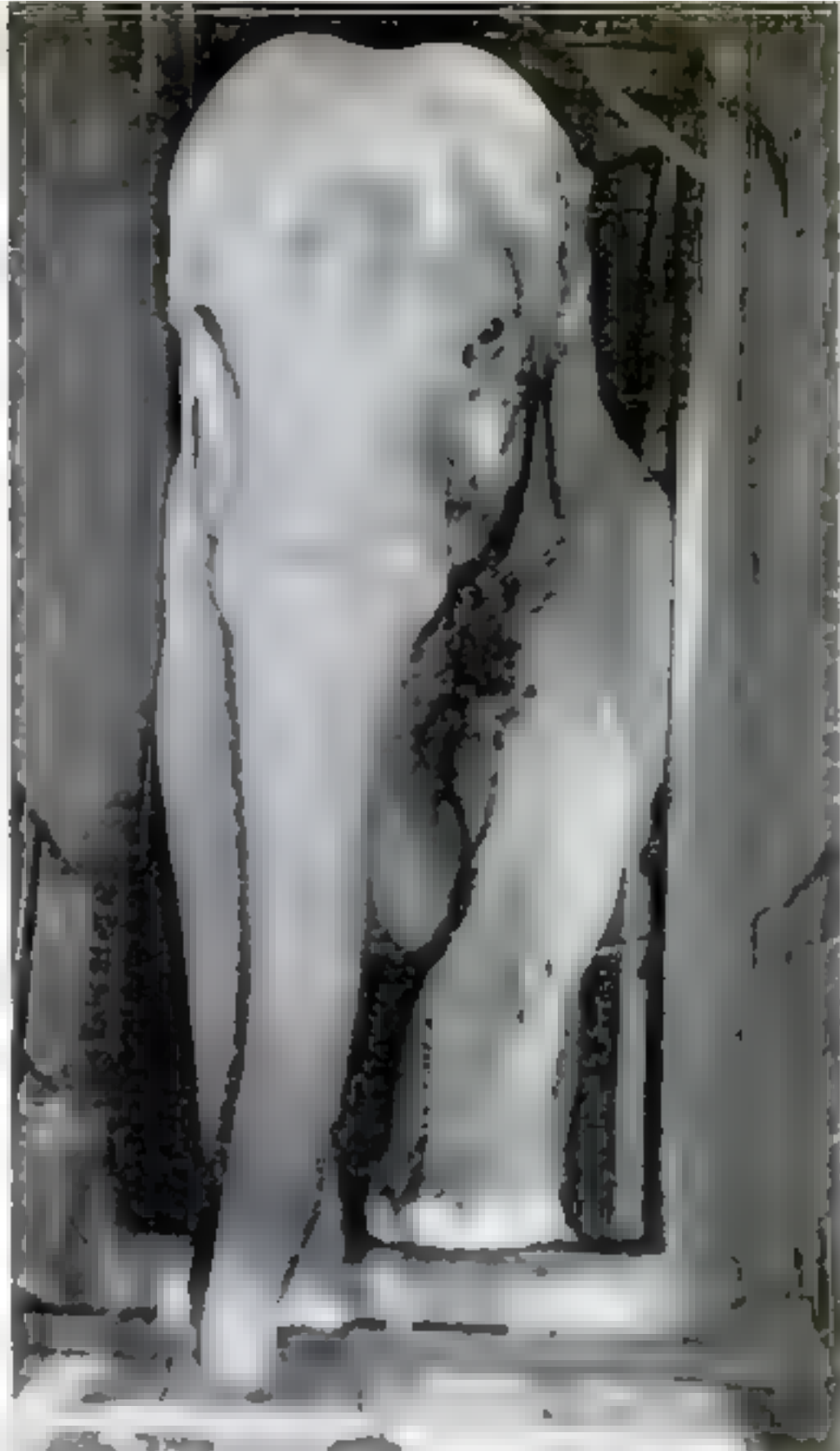
CAN YOU BEAT THESE PICTURES?

Have you a curious photograph showing some odd scene or happening? Send it to **POPULAR SCIENCE**. We will pay \$5 for any photo used in this department.



THUMBS UP Idea is carried by this San Francisco victory potato. It does not represent a new variety, but is merely a sport or deviation from normal type

BETTER EXHALE, Pachyderm, or you won't make it! After his act at the Shrine Circus in Chicago, this elephant was so full of peanuts that he had difficulty in getting out

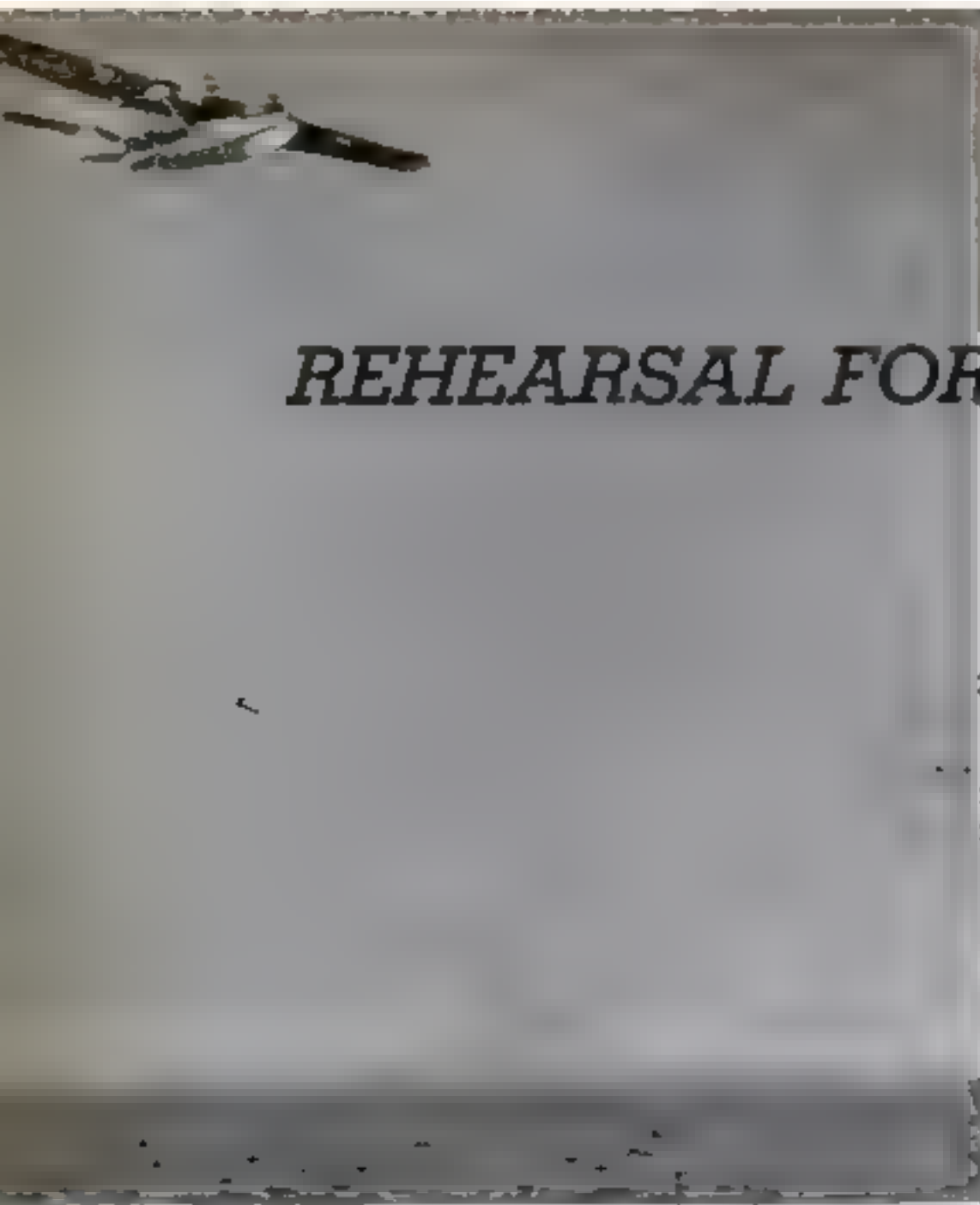


REPLICA OF MESSINA CATHEDRAL was built of ration tins by Corporal Vincenzo Sergi at an RAF prison camp in North Africa. Italians taken prisoner in the African and Sicilian campaigns are paid for all useful work



HE'S CROSSEYED; not the man, the cat. Chances for a corrective operation are slight; he is too valuable as an ad for his owner's shoe-repairing business





Aerial torpedoes are test-fired from flying boats. "Exercise heads" filled with water take the place of TNT-filled war heads. When the run ends, the exercise head empties, buoys up the torpedo, and sticks its yellow nose above the surface so it can be easily spotted by planes

REHEARSAL FOR DESTRUCTION

Torpedoes make test runs at a Navy range to show what they can do to enemy ships.

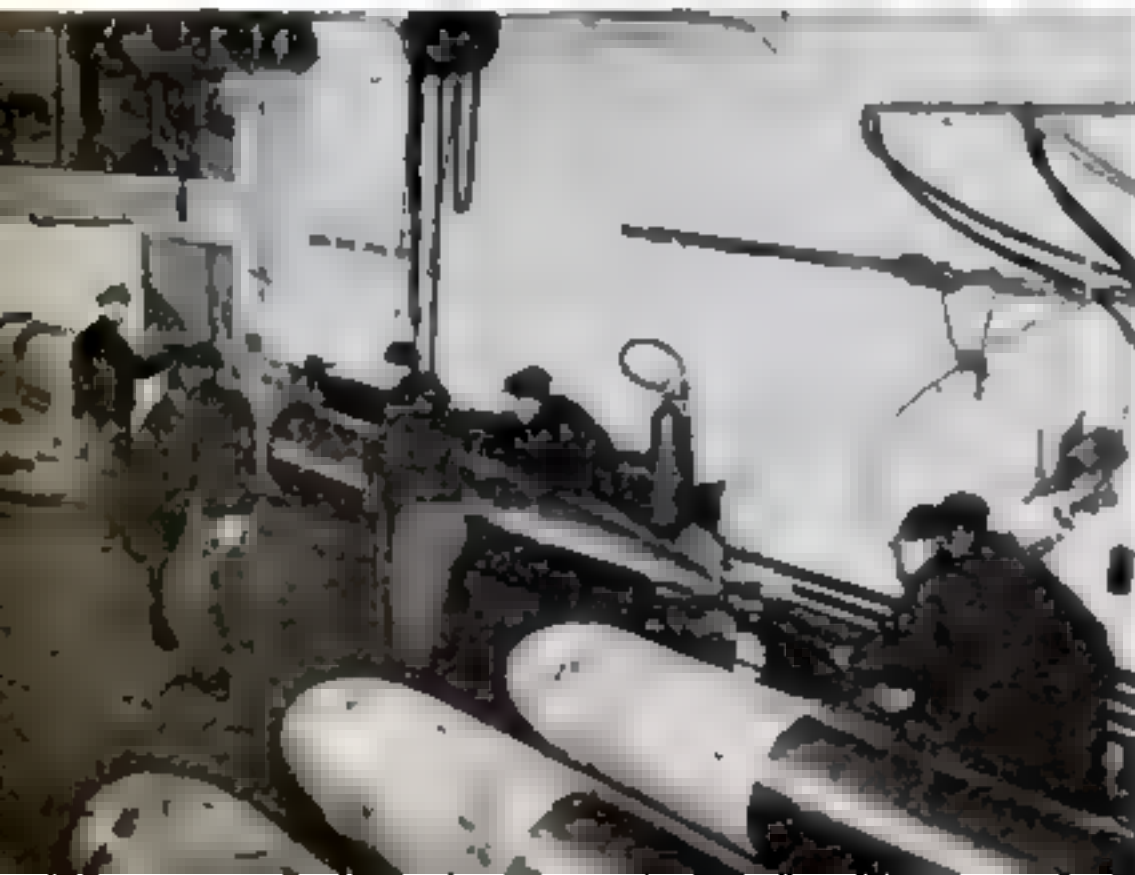
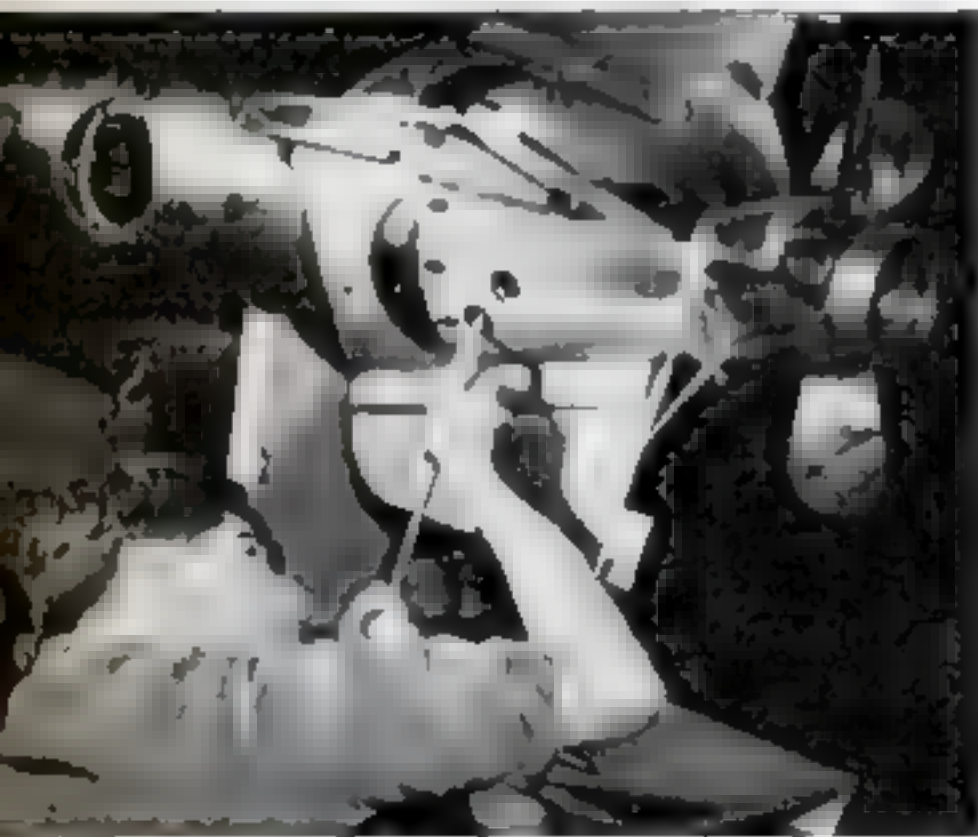
SLEEK, shiny torpedoes now race through the waters off Montauk, Long Island, peacetime haunt of deep-sea anglers. Here, at a naval testing range, long, slim "fish" that are launched from ships, and stubby ones that are dropped from planes, are repeatedly test-fired. Trial runs are made for speed, accuracy, and ability to stay at the proper depth. There aren't many dull moments on the range. Every time a "fish" hits the water, a

speedboat races alongside for a few hundred yards to track the monster should it suddenly run wild. Men in range boats clock the projectiles as they swish by, and then planes lead the retrieving boats to where the spent torpedoes have surfaced.

Unruly torpedoes are sent to the repair shop for readjustment as often as may be required. Torpedoes are guided by gyroscopes and driven by twin props whirling in opposite directions

A "fish" of the type used by ships is readied for test-firing from a tube (lower left). If it becomes a "surface runner" and suddenly goes wild it may smash up one of the range boats. Below: aerial torpedo gets a short-drop test

Official U. S. Navy Photographs



General Mud Meets His Match ... Chemical Rainproofs Soil

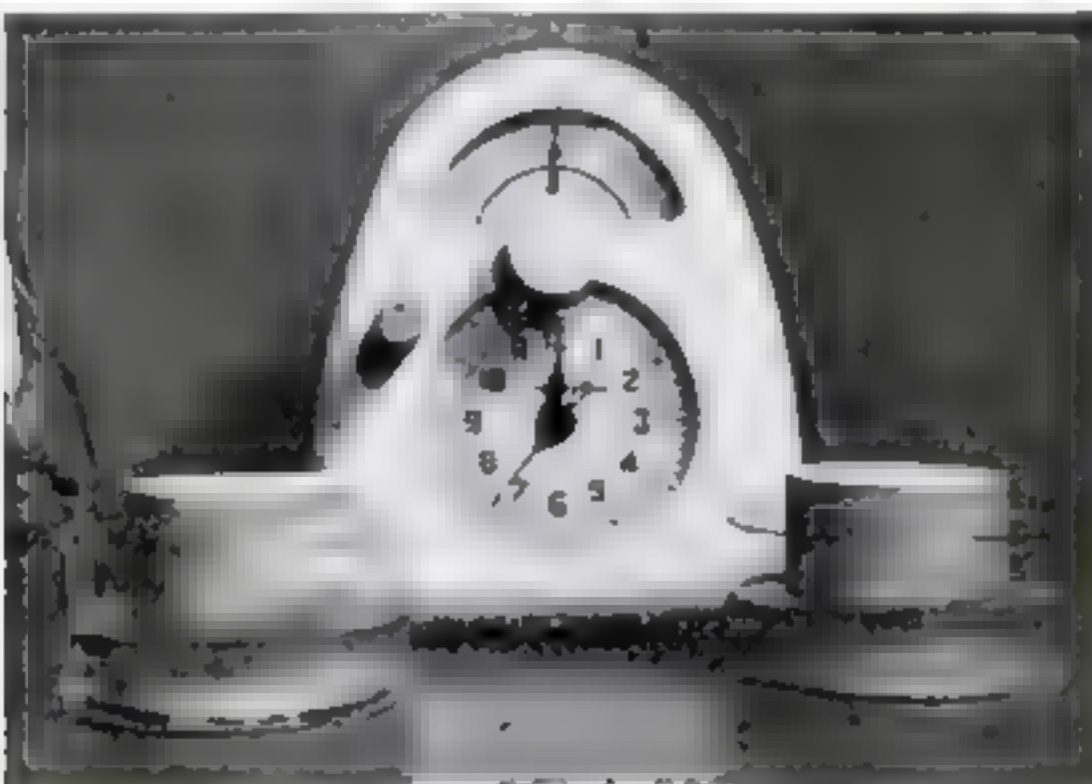
A RESIN compound that banishes mud has just been announced by the Hercules Powder Company, of Wilmington, Del. Used to waterproof soil to a depth of about six inches, the tan-colored powder, known as Stabinol, repels rain and prevents upward seepage of subterranean moisture. Exacting tests have demonstrated that the method keeps highways and airport runways in full service at all times. This makes it a military asset of prime importance.

For best results the chemical is applied when the soil is neither dry nor muddy, but contains about 85 percent of moisture. First the area is plowed, then Stabinol is added, and finally the surface is rolled firm. Thus treated, the earth should remain mud-free for years.

Economy of the treatment offers an outstanding advantage. The chemical itself costs only three cents a pound. And the expense of laying it brings the total expense up to no more than 30 cents a square yard, a small fraction of the cost of a cement or concrete roadway.



The amount of Stabinol in the small beaker is all that is required to stabilize the soil in the larger vessel. Ratio is 100 to one. The new chemical costs only three cents a pound



1 In a demonstration of Stabinol's ability to waterproof soil, two well-compacted cores of earth are both set in water. The core of the right has Stabinol



2 After 17 minutes the untreated core of soil at the left begins to settle in the dish its base gradually turning into mud. The core at right remains firm

3 A few minutes later, a one-kilogram weight is placed on top of each core. The one at the right supports the weight. The other promptly collapses into a mush

4 After an immersion of 30 minutes the treated core is removed from the dish. It has retained its original shape and has left no deposit of mud in the water



So You Think the Germans Are Giving Up!

By COL. JOHN R. (KILLER) KANE

*Former CO of a heavy-bomber group
in the Mediterranean Theater**

We're beating the Nazis, but their airmen still think they are going to win. Overconfidence on our part can help them.

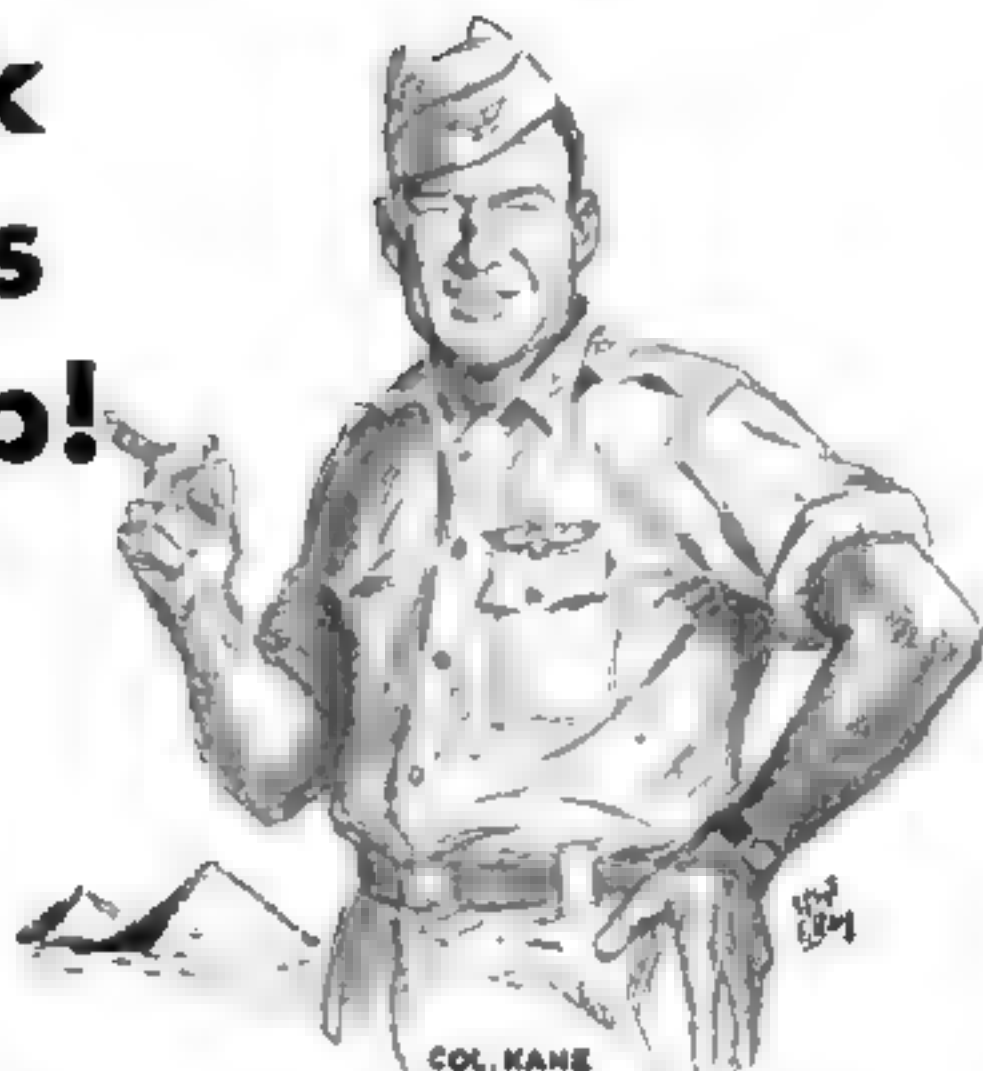
GERMAN airmen still think they are going to win this war. And we'll do them a big favor if we permit ourselves to get overconfident.

The "easy victory" boys who think the war is all but over never had their formations shot full of holes, their men knocked out of the sky, or their missions ruined by the highly skilled attacks of a cunning and powerful enemy.

I fought the Germans all across Africa, in Sicily, in Italy, and in the skies over occupied Europe, and I warn you that we are still a long, long way from victory. We will beat the Germans—there is no doubt of that—but the bitterest and bloodiest air battles of this war are still to be fought—battles that will make Schweinfurt and Regensburg and Ploesti look like peacetime picnics.

The Jerries today are flying better airplanes than ever before—planes with more powerful armament, improved ammunition, and more efficient engines which can deliver more speed and can climb to higher altitudes. They are concentrating most of their production on fighter aircraft, and the machines they are now turning out are more than just formidable foes; they are deadly airplanes, and it takes all we've got to knock them down.

Their pilots, instead of deteriorating, have improved. It is true they have lost most of their old first-line flyers and that the pilots who have replaced them are just kids. But these youngsters are products of the Hitler Youth movement—fanatical Nazis who are completely sold on *der Fuehrer* and the Fatherland. Take a German kid, warm him over with goose-stepping and heel-clicking, add Prussian discipline, feed him for six



years with "master race" propaganda, and you have a fighting man who is not afraid to die. The new Nazi pilots are as aggressive and dangerous as the veterans of a year ago.

The German airmen are now defending their own homeland—and that has brought even more fanaticism to their fighting. Previously, they seemed eager to enjoy the role of conqueror against defenseless countries; now they see their own cities blasted by the Allies' bombers, and they are striking back with a sense of revenge which borders on savagery.

Our own men are doing a great job, but it stands to reason that we would be fighting a more desperate battle if Washington and Chicago and Dallas were being leveled by German bombers. A people defending their own homeland have a distinct morale advantage over the attackers. The Jerries are fighting harder now than they ever did before.

German soldiers, from the top-ranking officers down, are military robots. They believe what the high command and the propaganda boys want them to believe. And virtually every one of them is still sold on Nazism and the fact that Germany eventually will be victorious. They have had drummed into them the belief that one day soon the Germans will start a big offensive which will defeat all their enemies at once. You can laugh at that if you like, but the Germans believe it and it makes them fight harder because they still feel they are on the winning side. German soldiers believe our east coast has been destroyed by Nazi bombers. Upon seeing New York, Nazi prisoners remark that we have done a good job of rebuilding it after

* Reprinted by permission from Air Force, the Official Service Journal of the U. S. Army Air Forces.

the raids by their bombers.

The Jerries are going to get tougher. As they are pushed back closer and closer to Germany itself, our battle will become more difficult. Their lines of communication will be shorter, and that advantage cannot be overestimated. One of the reasons for the failure of the *Luftwaffe* in Africa—and also for the defeat of the German ground forces—was their inability to get sufficient supplies to keep their planes in the air. This will not be the case when they are working out of Germany itself. Then the difficulties of supply will be ours.

It is undeniably true that the Allied air forces have wrought incredible damage on Germany. But the Nazis have demonstrated their ability to put their cities back in working order.

Many of the manufacturing centers which have been bombed out are once again in production—perhaps not at full strength, but turning out enough material to cause us plenty of trouble. German engineering ability has never been doubted.

Remember that you are fighting an enemy who not only doesn't believe he is licked, but actually feels he is going to win the war. Indications of that belief are obvious to everyone who has ever fought the Germans. You have probably heard stories about a lack of enthusiasm on the part of Nazi pilots—of unwillingness to fight, particularly when outnumbered. Don't believe a word of it. I know of many cases where formations of 30 to 40 B-24's have been attacked by only five or six enemy fighters—and I mean attacked. These Jerries didn't just play around outside the formation. Probably they knew they were going to get shot down, but they came in, raked our planes, dived away, and came up again for more. Even when a single German finds a strong Allied formation, he will rarely run away. He'll hang around making passes, trying to knock one of our ships out of the formation so he can jump on him. Then he'll start to work on a second plane. I found that to be true from El Alamein to Italy. And it will get worse the longer the war continues.

When the Germans send a formation of bombers over London at night, they know full well that those planes will run into



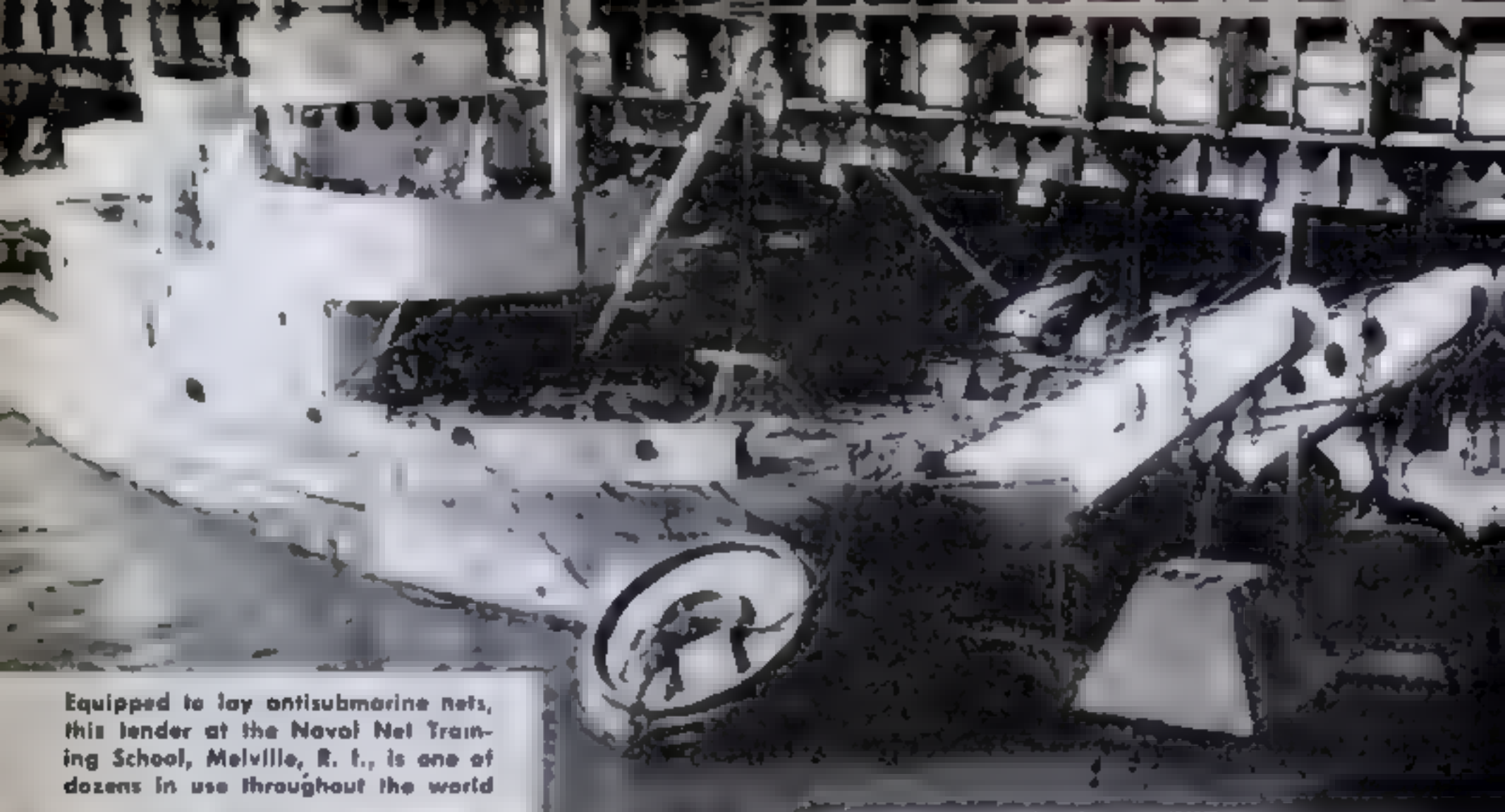
German soldiers believe our east coast has been destroyed by Nazi bombers. Upon seeing New York, Nazi prisoners remark that we have done a very good job of rebuilding it.

probably the strongest defensive setup in the world—intense flak and plenty of heavily armed fighters. Yet their bombers continue to come over just to see what's going on, to try to break up any preparations and, generally, to create as much damage as they can. The few bombers Germany has are highly important to her. They realize there is little chance of the entire formation getting back against the British defenses—yet they still send them over. Does that sound like an enemy who is unwilling or afraid to fight?

The Jerries guess wrong sometimes, but you can usually count on a strong fighter force waiting to meet you. On most of our operations we found fighter opposition before we got to the target, while we were over the target, and long after we left the target. We can rely on the fact that the Jerries will chase us until they are out of ammunition and gas, then refuel and rearm, and come after us again.

The Germans will fight in the air until they are down to their last bullet and last gallon of gasoline. And they will be licked only by the sheer weight of our aircraft knocking them out of the air and destroying them on the ground—and not by our wishing they would fall.

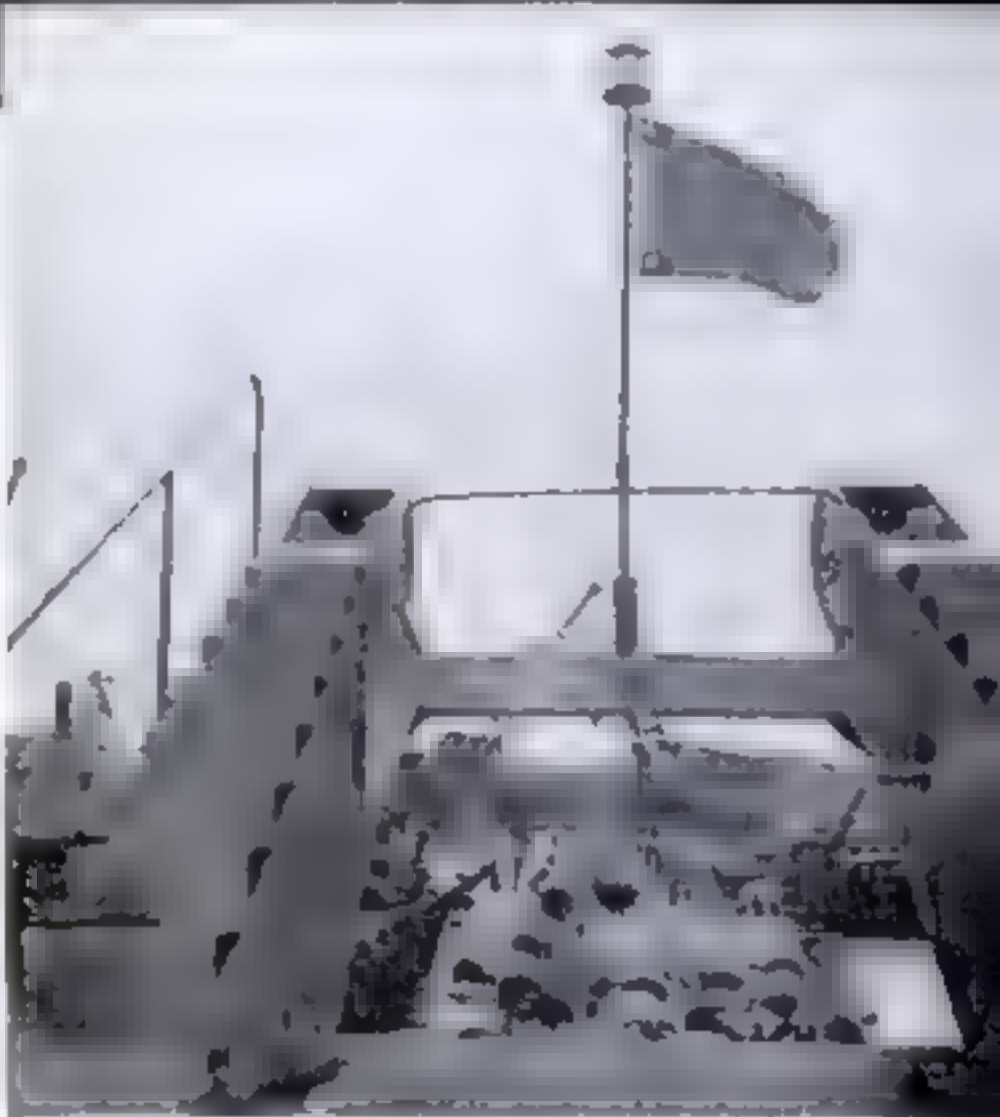
We're going to beat them, and beat them badly, but it is going to take a lot of high-powered fighting and close co-ordination to do it. Remember, the Jerries are not afraid of us.



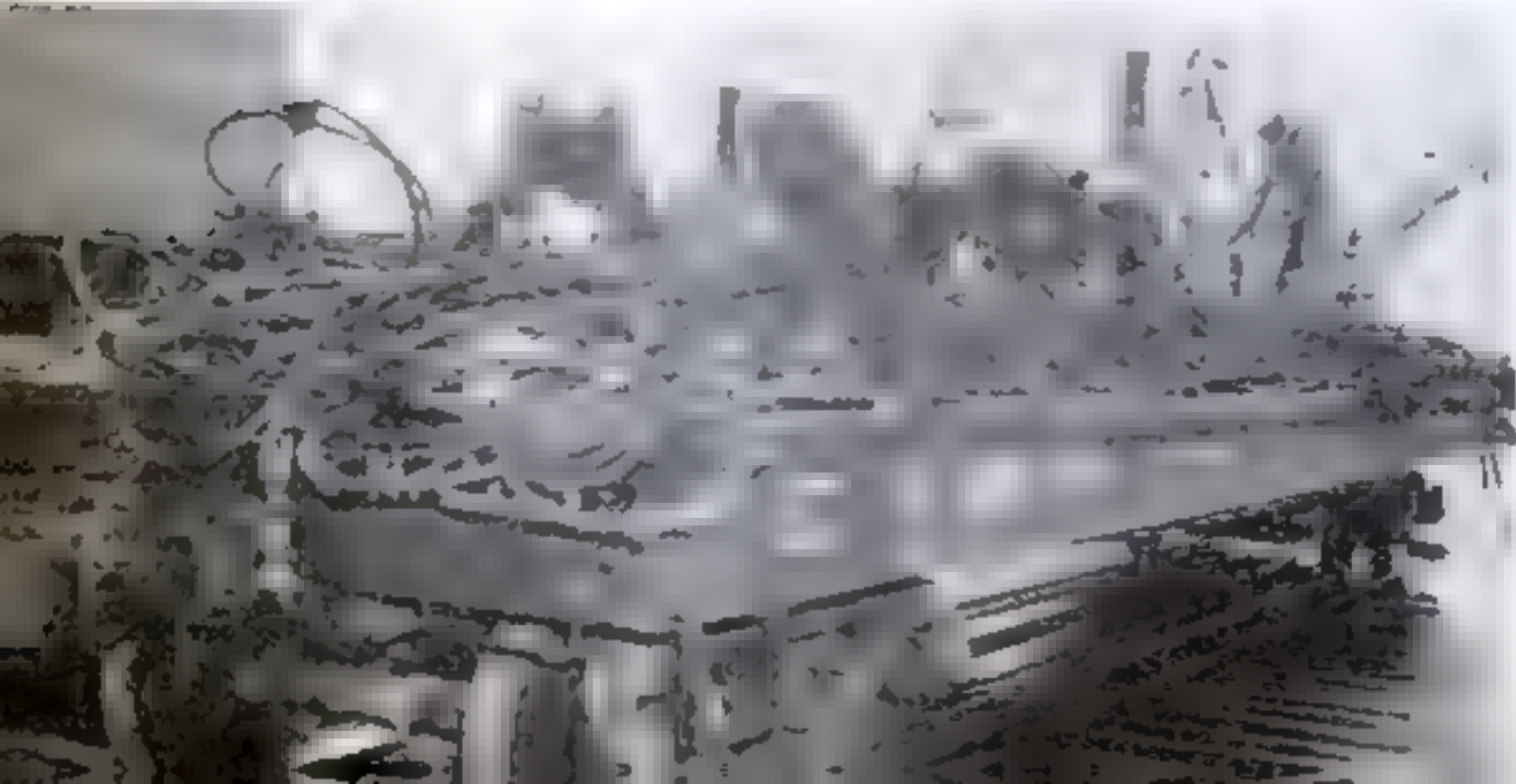
Equipped to lay antisubmarine nets, this tender at the Naval Net Training School, Melville, R. I., is one of dozens in use throughout the world

Seining for Tin Fish

NETS of steel stretched across the mouths of harbors and around anchorages fulfill the purpose of straining out enemy submarines and torpedoes that might otherwise slip by the defenses. Spreading and maintaining these nets is an arduous task performed by the Navy's two-horned "YN" net tenders. Nets may be more than two miles long, reaching from the surface of the water to the bottom. Despite their rugged construction, they are sometimes damaged by storms.



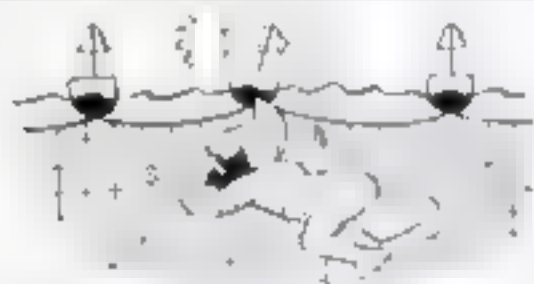
Looking through a tender's two-horned prow, over which winch wires are passed to raise and lower the heavy and unwieldy sub net equipment. In the background men are working on an underwater steel web. For continuous protection, repairs to nets damaged by storms must be made without delay



Sections of an antisubmarine net are loaded on a Navy flat car for removal to a tender. The seal doesn't leave the men



Net depot crew at Norfolk, Va., assembles the linked panels of an antitorpedo net, and shackles the barrel buoys that hold up the net. In the right background is the snail-like bow of a net tender. At right, a crane lifts a net so that crewmen can get at it to complete their work. Floats, the watertight barrels scattered in the foreground, are shackled to the big net, and panels are secured to make a complete web ready to function against the enemy



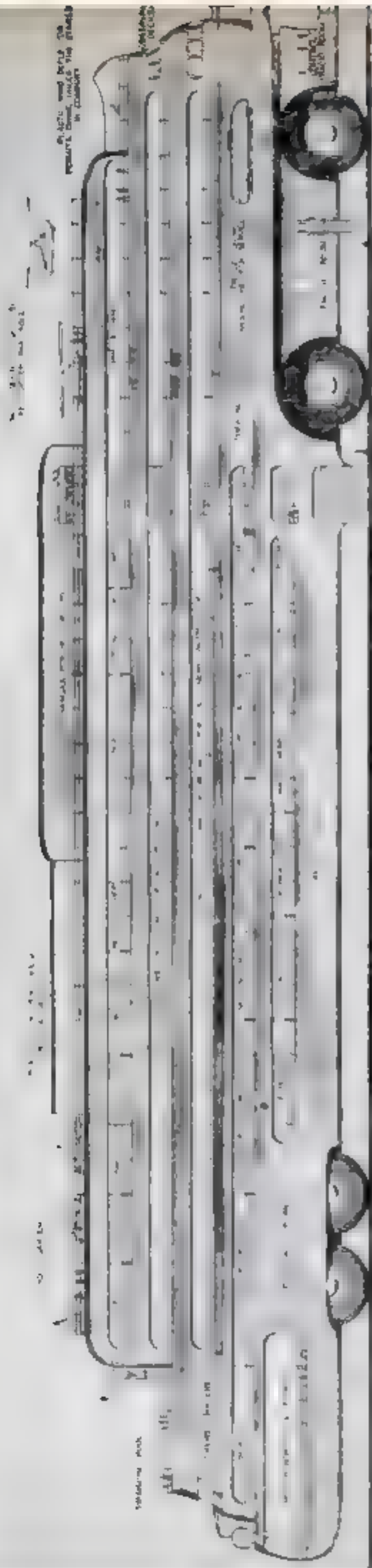
IN 42 B. C., a Roman general used nets tagged with bells to prevent his enemies' escape by swimming



A WHALE was stymied after following a convoy into a Caribbean port because they closed the gate on him



To show up any possible weak links in the net, torpedoes are fired at it and the results of the test are carefully checked. The flotation buoys hold up the net, which is securely anchored to prevent shifting due to wind pressure, tides, or attempted penetration by enemy subs or torpedoes



Postwar Super-Duper Bus May Carry 600

PPIPE-DREAM exaggerations of what Americans may expect in the postwar world have impelled the engineers of the American Car and Foundry Company, Philadelphia, to take a busman's holiday and design the "600-passenger bus of tomorrow (or some day next week)." They modestly give credit to the source of their inspiration, but claim priority on such intricate and technical features as the process of waterproofing the passenger compartment against leakage from the swimming pool; how to use the draft created by the helicopter rotors for ventilating; how to operate the bus with

one man (or at most, two); plan for mosquito-proofing and fertilizing the roof garden; and the net for catching high divers who overshoot the mark.

The public, alap-happy from promised wonders, will at once realize that this uncommon carrier has everything the heart could wish. The overcritical may carp at the lack of road curves wide enough to take the bus, or the absence of gyroscopic stabilization to compensate for sway that might throw off one's bowling game. However, such minor problems will not delay the triumphant march of progress.



Your
Pin Up-

CONSOLIDATED CORONADO

(P B 2 Y)

GIANT NAVY PATROL BOMBER

NEXT MONTH:

P-70 HAVOC NIGHT FIGHTER



James
H. Smith
1870

How Games Are Used to

While competing in exciting sports—part of the American Red Cross water-safety course—new swimmers gain self-forgetful courage.

Drawings by FRANK HUBBARD

INEXPERIENCED swimmers can free themselves from fear of the water, get used to diving, and learn a variety of strokes by playing simple games. Because the American Red Cross has discovered these facts, it has made fun an important part of the curriculum even in water-safety classes for instructors.

Games lure timid souls away from the shelter of the pool's rim, accustom them to being toppled over, bumping into others,

and turning somersaults. The Red Cross has taken a leaf from the book of the small boys who play tag down at the old swimming hole, but it has carried the idea further and devised games that develop almost every kind of aquatic skill.

"The fun method is particularly good for adults who think they are too old to learn," says Mrs. Gabrielle M. Ranallo, assistant director of first aid, water safety, and accident prevention for the Red Cross in Brooklyn, N. Y. "It helps them overcome their timidity. It keeps them active in a group and takes their minds off their fears."

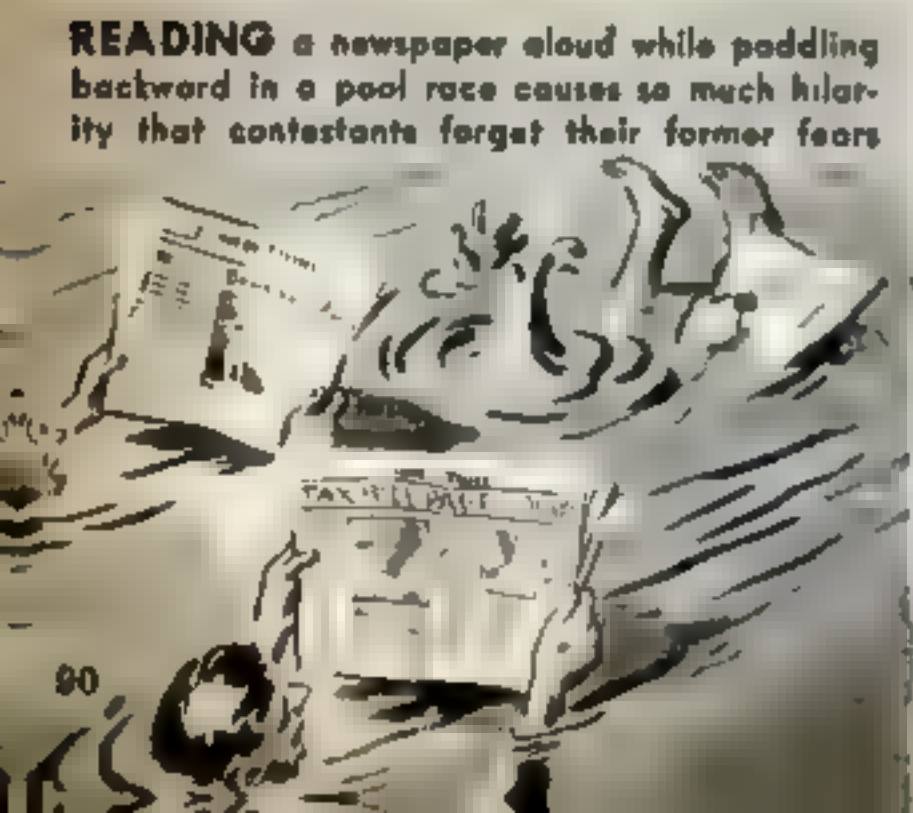
There are different games for beginning, intermediate, and advanced students. Many are water variations of familiar obstacle races, or parlor games such as anagrams, using stones on which the letters have been painted.



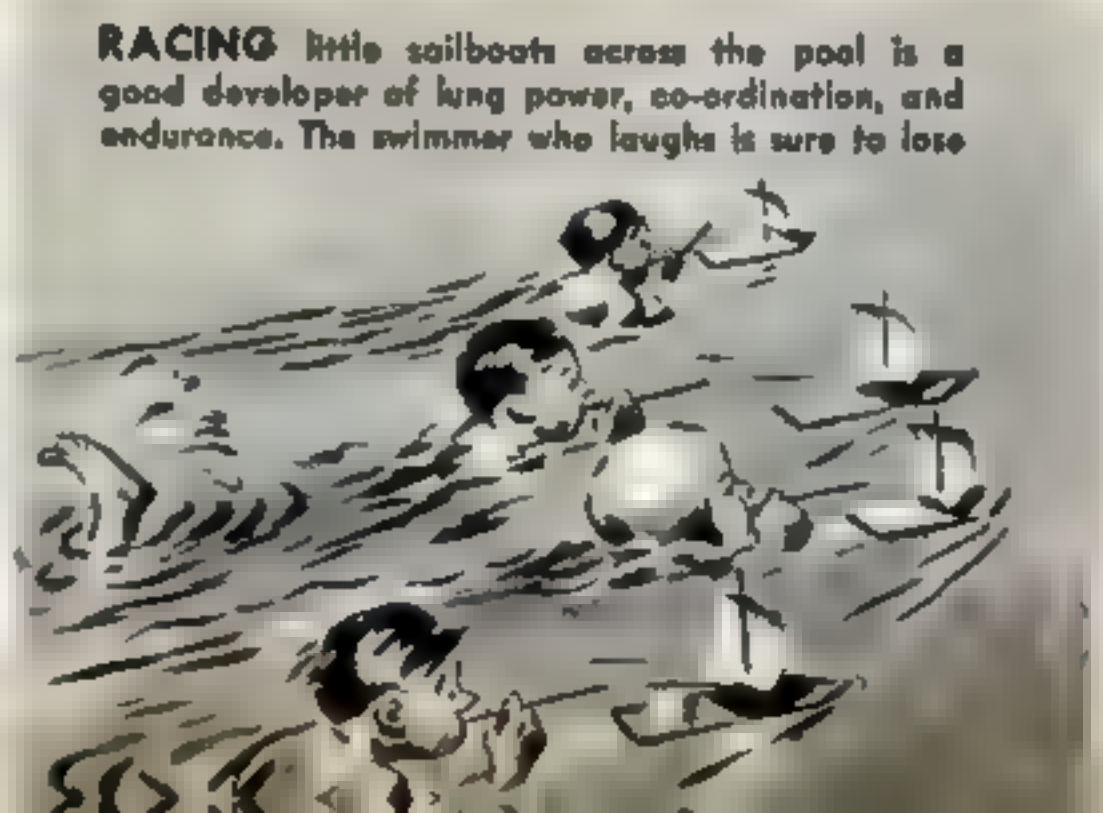
DODGE BALL encourages confidence, for it is a deep-water game in which the players will find it impossible to avoid frequent duckings



FETCHING objects from the bottom of the pool as a part of a competition teaches beginners not to be afraid to get their faces under water



READING a newspaper aloud while paddling backward in a pool race causes so much hilarity that contestants forget their former fears



RACING little sailboats across the pool is a good developer of lung power, co-ordination, and endurance. The swimmer who laughs is sure to lose

Banish Fear of Water



DUCKING FOR APPLES is a water stunt that is popular with those who are learning to dive. It is a regular part of the aquatic-fun training.

LEAVES BALL - TAKES 2 BRICKS

LEAVES BRICKS, GETS OUT OF WATER, SITS IN CHAIR, DIVES BACK IN, SWIMS TO FINISH.

TIMING induces timid students to forget fear in playing this competitive swimming game involving a three-way circuit of the pool.

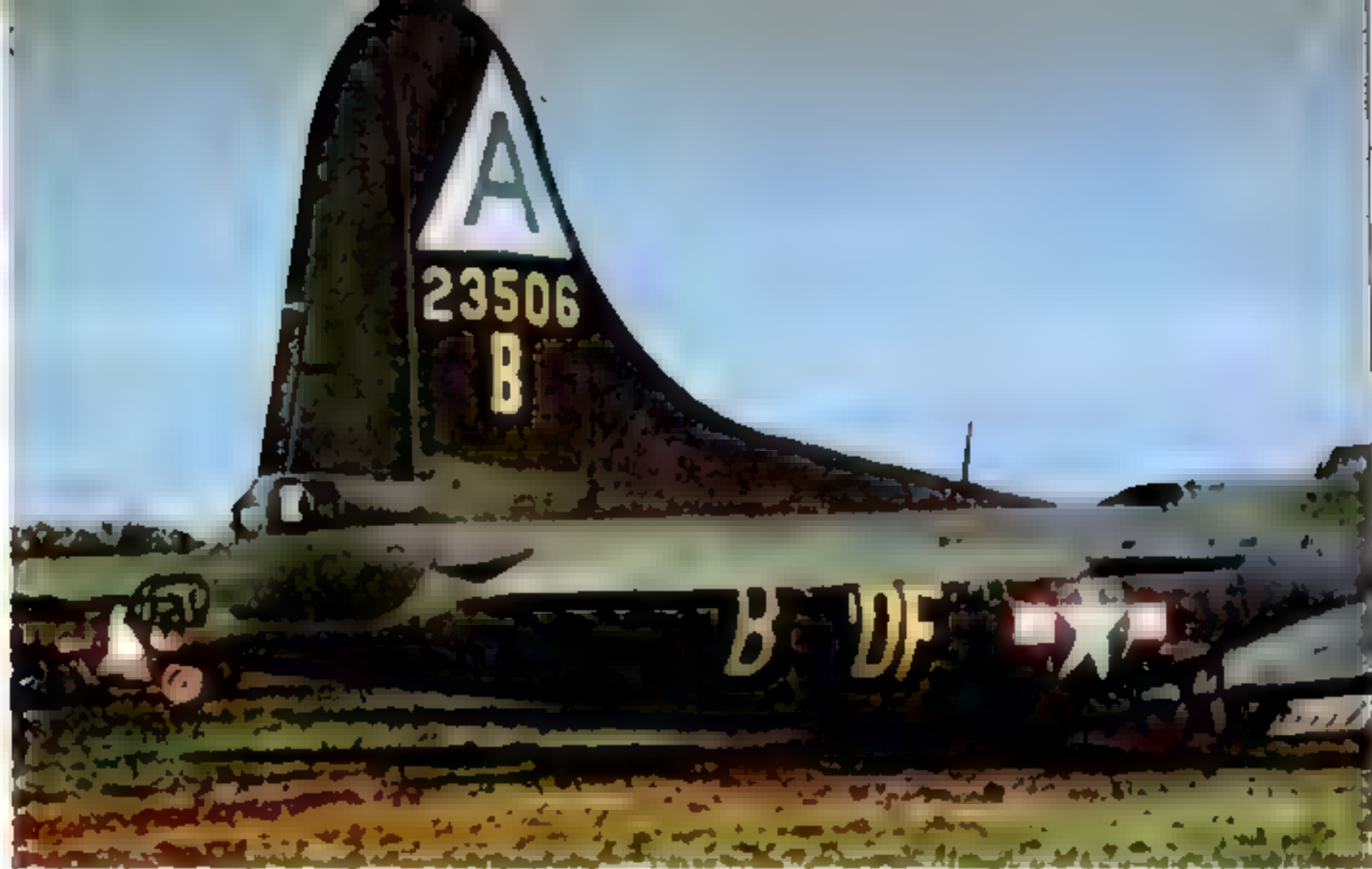
START

FINISH



ANAGRAMS. Large stones on which letters are painted are fetched from the pool floor in a water version of the parlor game.

WATER BALLETS and pageants develop expert smoothness not only in swimming but in teamwork and co-ordination. They present the game idea dramatically.



FLAT ON HIS BELLY in a muddy English grain field, the B-17G *Sir Baboon McGoon* looks like a job for the junkman. Returning from one of its first missions over Germany, the Fort ran out of gasoline

Another Triumph for Yankee "Know-How"

WHEN SIR BABOON MCGOON MADE A BELLY LANDING IN AN ENGLISH FIELD, IT MEANT A HURRY CALL FOR ONE OF OUR CRACK ETOWSA MOBILE REPAIR OUTFITS

THE *Sir Baboon McGoon* was a B-17G, one of the first of the new chin-turret Fords to reach the European theater of operations. Coming back from one of its first bombing raids over Germany, it ran out of gas and landed flat on its belly in a muddy English grain field. In a short time it was back in the air, again toting bombs over the Continent—and this is the story of how that came about.

By **HICKMAN POWELL**

Photos by **HAROLD KULICK**

Popular Science Monthly's
War-Front Reporting Team

(Unfortunately, the *Baboon* could not go back to its original crew, whom it brought in safely with its belly landing. A few days later, in another Fort, those boys went down.)

The rehabilitation of the *Sir Baboon McGoon* was the work of one of the mobile repair units, operating under the Eighth Air Service Command, which during the last year put more than 600 Flying Fortresses back in the air when they had crash-landed or when their battle damage was too severe for ground crews of their stations to handle. A smaller number of such units does similar work for Thunderbolts, Marauders, and Liberators. Others, with more specialized equipment, follow our invading ground forces.

This work is one of the newest jobs in our Air Forces. There were mobile repair units before the war, but they were never developed very far, *(Continued on page 96)*



Cutting a straight ditch across the level acres, the Baboon came to rest. Principal damage was done to chin and belly turrets. The crew escaped unscathed, to go down a few days later with another Fortress

...A Fortress Lives to Fight Again

CALLED TO THE SCENE, a mobile repair unit rolls over narrow English roads and through picturesque villages. It consists of two large tractor trailers, one containing a fully equipped machine shop, the other a supply of spare parts and the repair crew's effects. The motto of the unit, "We're All in This Together," seems to appeal to the natives when the big vans stop, as at the right, to ask the way. A jeep goes ahead as pathfinder to look for road hazards



INSPECTION of the damage is made by Major Rooney, commander of all the repair units in this district. He finds Sir Baboon in good shape except that the chin turret has been shoved up into the fuselage, the belly turret is smashed, and the propellers and engines are damaged. Forts that are too seriously injured for a quick repair job are dismantled and parts used for replacements



LIFTING WITH BALLOON JACKS



1 First step is to get the plane off the ground. Balloons are unloaded from a truck and unrolled. Tripod jack at right is for use under the plane if landing-gear wheels won't come down

2 Four balloon bags, each made in three compartments, are employed in jacking up the plane. They are laid on the ground under the wings, one on either side of each outboard engine nacelle

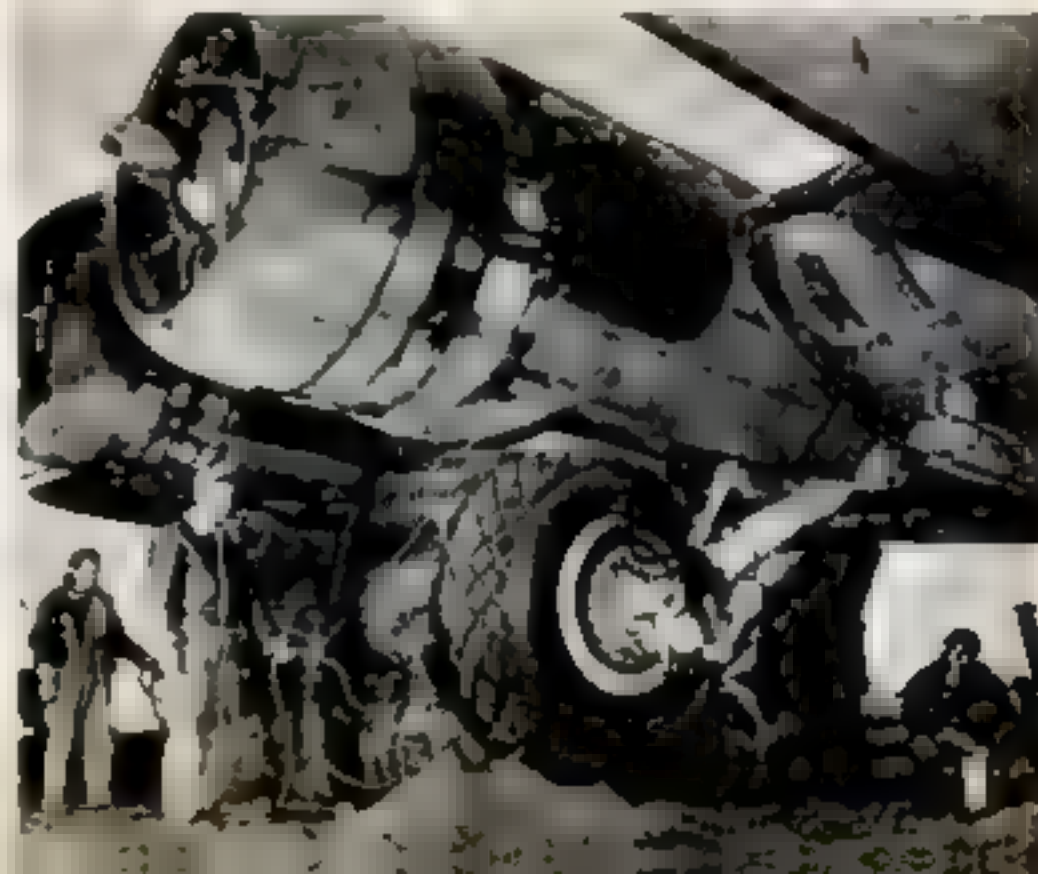


3 Connected to the bags by hose lines, a mobile gasoline-powered compressor starts pumping air into the balloon jacks. This method is less injurious to wings than mechanical jacks

4 As the bags are pumped up to about 10 pounds pressure, the crippled Fort tends to tip forward on its nose. To hold it in balance, its tail is chained to a big truck driven up behind it on the muddy field

5 Swelling up under the thrust of air from the compressor, the balloon jacks lift the B-17 out of the ooze. Since all four bags fill simultaneously, Sir Baboon rises on an even keel

6 With wings and fuselage off the ground, landing gear is lowered to support the plane. If wheels had refused to come down, owing to damage, tripod jack shown at top of page would have been called for



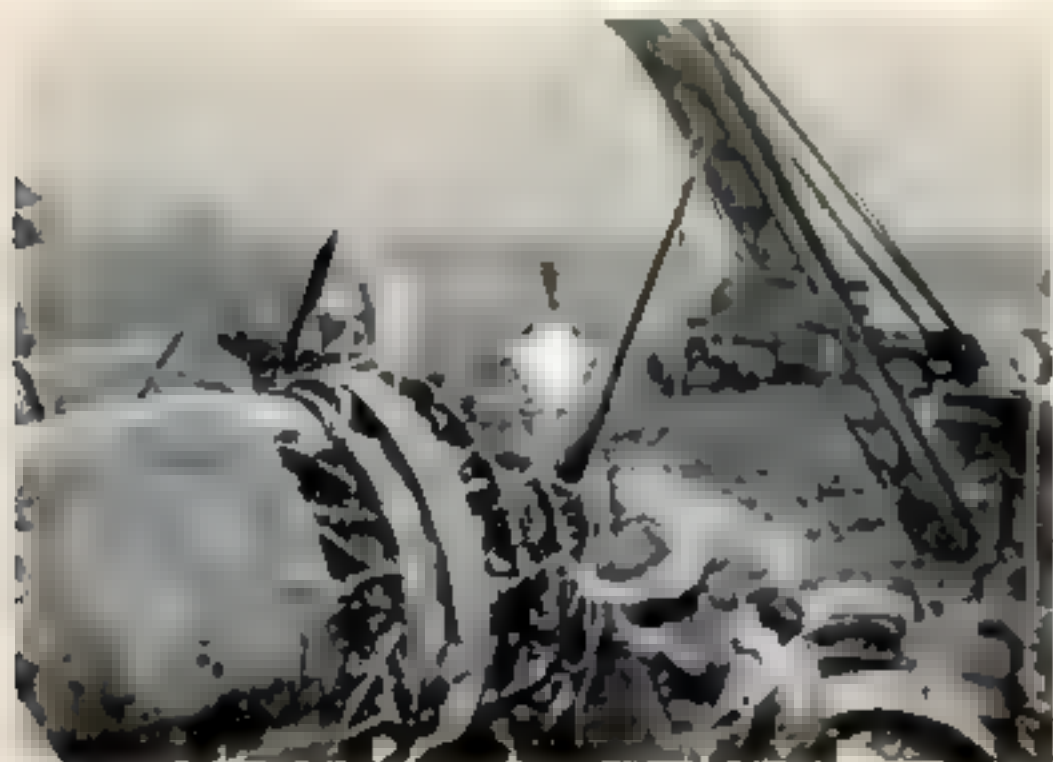


NOW FOR THE REPAIR JOB

CHIN TURRET. Sir Baboon McGoan led with his chin in the crash landing. The chin turret, which had been jammed up into the fuselage, had to be removed and hole covered up pending further repairs at a depot



BELLY TURRET also took a beating in the slide across the field. In fact, it was ground to bits and parts of it broke off, rolling back under the plane, tearing the skin of the fuselage

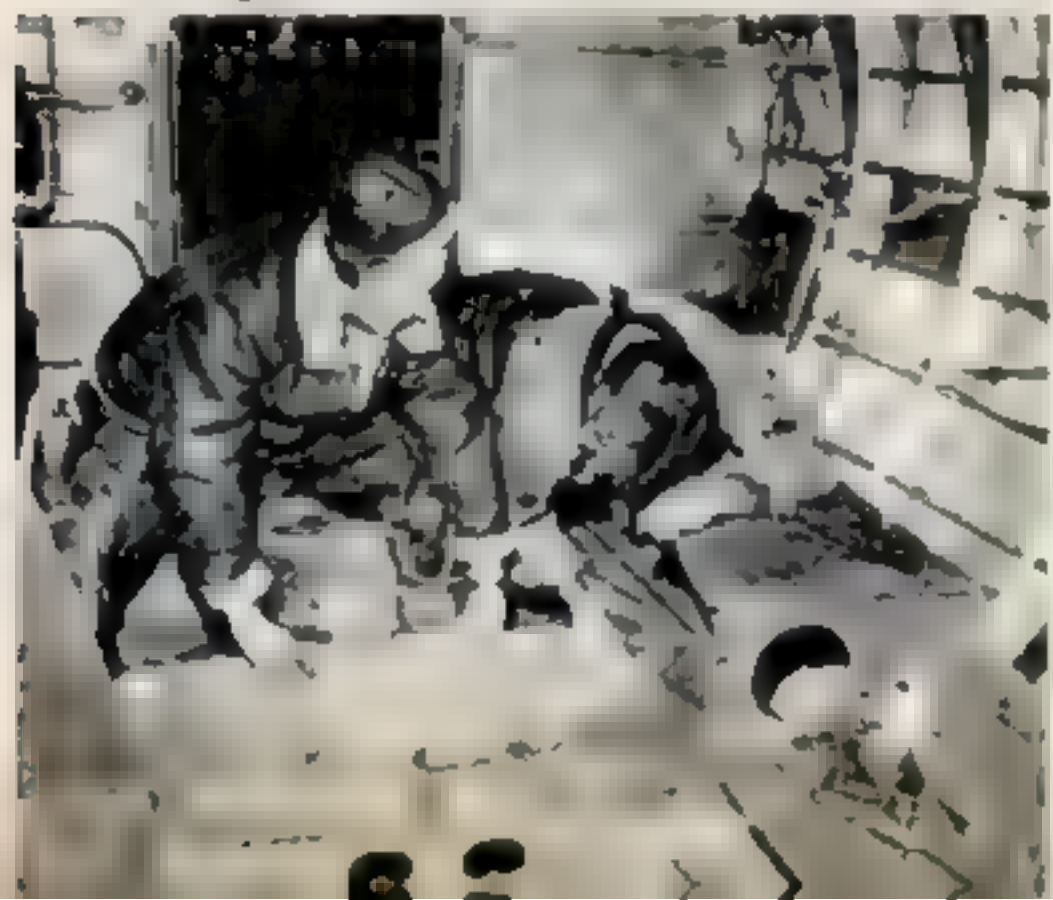


NEW ENGINES and propellers are installed to replace those damaged in the crash. Jonery was all over the place supervising the job of setting the big Cyclones in place and truing them up



TEMPORARY RIBS fill in the space where the bashed chin turret came out, to strengthen the frame and provide a base for the temporary covering. Same is done for belly-turret opening

BELLY PLATES are put in to patch up the damage done by the ripping out of the belly turret. The skin on the underside of fuselage, torn and rumpled when turret ground underneath it, had to be made smooth



CHIN UP. This is how the underside of the Baboon's nose looked when the repair crew got through with it. The turret will be replaced at a depot where working conditions are better





MUD was the element in which the repair crew lived and worked. Throughout the job, frequent rains soaked the soil of the field and trucks churned it into a sea of slime. Feet, wheels, tools, and clothing were caked. While floundering around with his camera to make these pictures, photographer Harold Kylick suddenly discovered that his flying boots had pulled off and he was wading in his sock feet

because with many less airplanes there were few crashes, and no battle damage. But once the bombing of Europe began, the need became great and immediate. Under leadership of technicians of the Lockheed Aircraft Corp., mobile crews were hastily organized, largely from Army enlisted personnel who thus got training. Well before the end of the year the Army had taken over the entire job. The units were so new and flexible that they still had no table of organization, which seems to be the Army hallmark of legitimacy. But they were putting the Forts back in the air, and that was what counted.

When the *McGoan* went down on a farm in Suffolk, the news was reported to a strategic air depot 30 miles away, where Maj. John F. Rooney heads up the repair

units covering this half of the country. (Rooney hails from Dickinson, N. D., and more recently from Louisville, Ky., where he was a chemist specializing in such things as the polymerization of synthetic resins for use in paint and varnish. It's strange how this war has mixed up our skills and talents; Rooney's technicians say the last year has made him a real expert at diagnosing the ills of damaged aircraft as well as at fighting red tape to get proper cigarette rations for scattered units moving around over several counties.)

Rooney went out and did the inspection job on this aircraft himself. Clearly it was a job for mobile repair. As a Fort will, this ship had come in across the flat grain field, not quite as gently as a baby carriage but just as smoothly as a bateau on

READY TO ROLL, Sir Baboon McGoan seems to be eager for the take-off. Vapor trails of brother Forts, flying over on their way to and from the smoking industrial centers of Germany, lure him back into the fight. With their work almost finished, the boys of the mobile repair unit view their handiwork proudly. They have saved a valuable piece of equipment for the finish fight on Axis oppression





A NEW NOSE replaces the one punched out by the chin turret. Here the new Plexiglas "goldfish bowl" is being put in place over the bombardier's compartment. During the earlier stages of the work, a dummy nose covered the opening to keep out rain and prevent damage to the instruments and controls inside. Up on the side of the fuselage you can see the plane's emblem, the comic-strip character from whom Sir Baboon took his name, represented running with his war club on the road to Berlin. The McGoon presented a relatively simple repair job, being less damaged than most



LAY THAT RUNWAY DOWN. While the finishing touches were being put on Sir Boboan, an outfit of engineers has moved in to prepare a temporary runway for the take-off. After bulldozers have leveled hummocks and filled ditches, a portable mat of steel panels is laid on the soggy soil (P.S.M., Mar. '42, p. 101). When finished, it is 1,800 feet long and only 65 ft. wide, narrowest so far used for such a job



a sandy beach, cutting a straight, shallow furrow in the earth. The *McGoon* had taken it on the chin turret; the belly turret had been ground to bits, and all the props had been torn out of shape, which had jolted the engines badly. Otherwise, save for a few flak holes, the plane was as sound as a bell. The task was simple enough, indeed, to be done by only half of a mobile crew, leaving the rest free to work on other junks.

This inspection involved a critical decision. A four-engine bomber is still a precious instrument of war. But production and deliveries in the ETO have so increased during the last year that if more than a certain number of days are required to re-

pair a Fort, the ship is considered more valuable as salvage than as a complete aircraft. It is lovingly taken apart in sections, and these parts are stored in a salvage yard, ready to act as replacements in other damaged ships. The hangar queen—a retired aircraft from which parts are swiped—is a tradition of repair depots. A salvage yard is a hangar queen acres in extent; row upon row of wing sections, wing tips, fuselages, ailerons, flaps—each a remnant of some ship which met misadventure, each ready again to take its place and go out fighting in another Fort.

(Fortress is still the official designation, but over here more and more you hear them called Forts. And it isn't merely Fort for



"HANGAR QUEENS" in the salvage yard of a strategic air depot. These are planes that cracked up too badly to be put back into the air. They have been taken apart where they fell and the pieces are stored here to supply replacement parts, thus helping to keep many other damaged planes in the fight



SIR BABOON FLIES AGAIN. Lifting off the temporary runway, the big Fort takes the air. After a little turret repair at a strategic air depot, it will be back on the job totting bombs into Naziland.

HAPPY LANDINGS! From the ground, the men of the mobile repair outfit wave goodbye to Sir Baboon McGoon. Tomorrow they'll probably get an SOS about some other plane that's crashed

short. There is also another tendency, indicated in the increase in masculine names for the ships. In the early days in the South Pacific a Fortress may have been a queen who died proudly. Over here a Fort is a stand-up guy that goes forth and slugs it out with the enemy. And a very masculine job that.

The actual repair of the *Sir Baboon McGoon* is a tale best told in pictures. So let us talk about the fellows who did the work—Joe and Jonesy and their crew, who are proud and happy in their job, and the Lieutenant, their engineering officer, who is probably the saddest, most frustrated man in ETOUSA.

An aircraft engineer in civil life, the Lieutenant is one of the few members of



the mobile outfit who had ever touched an airplane before a year or two ago. His professional knowledge, particularly of stress and strain and of the vulnerable, irreparable points in a Fortress, has provided the authority and confidence whereby several hundred bombers have been safely put back in the air to fight against Germany. *(Continued on page 199)*

REPAIR CREWS CEMENT ANGLO-AMERICAN FRIENDSHIP

ON THEIR OWN while working on McGoon, the boys slept in a bungalow on the grounds of an ancient castle. They took their meals at an old-fashioned English pub, the Crown, across below across the town's brick Emergency Water Supply tank. Although almost entirely free from military discipline, they have a splendid conduct record.

MINE HOST of the Crown became so fond of his American guests that he wrote letters to their parents telling what fine boys they are. He plans to visit them in the States after the war. The Yanks won his heart by carrying their beer well and always wiping their feet when they came in.

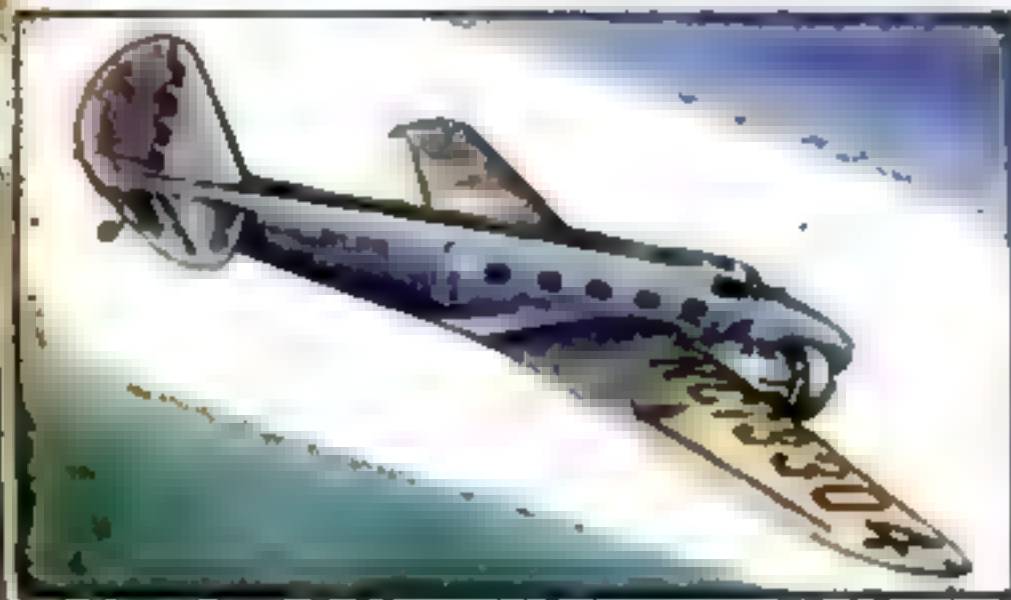




The Monomail of 1930, earliest of the Fort's ancestors, bequeathed retractable landing gear and all-metal skin



The B-9, which shamed the biplane fighters of 1931 with its speed, contributed largely to the Fort's swiftness

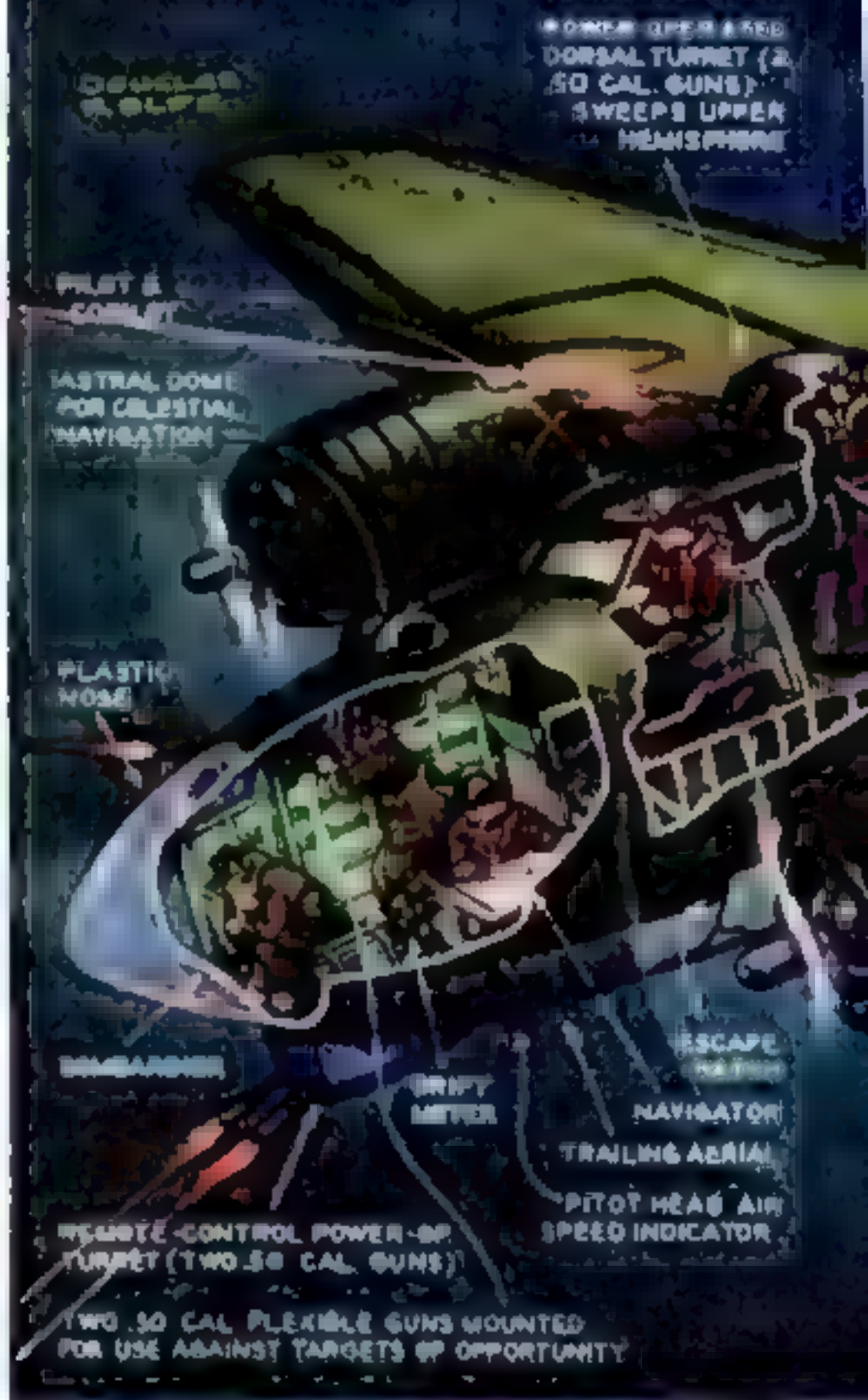


From Boeing's commercial transports, many of which are still flying after 11 years, came a family ruggedness



From its dad, the B-15, the Fort got four engines and many of its structural and operational characteristics

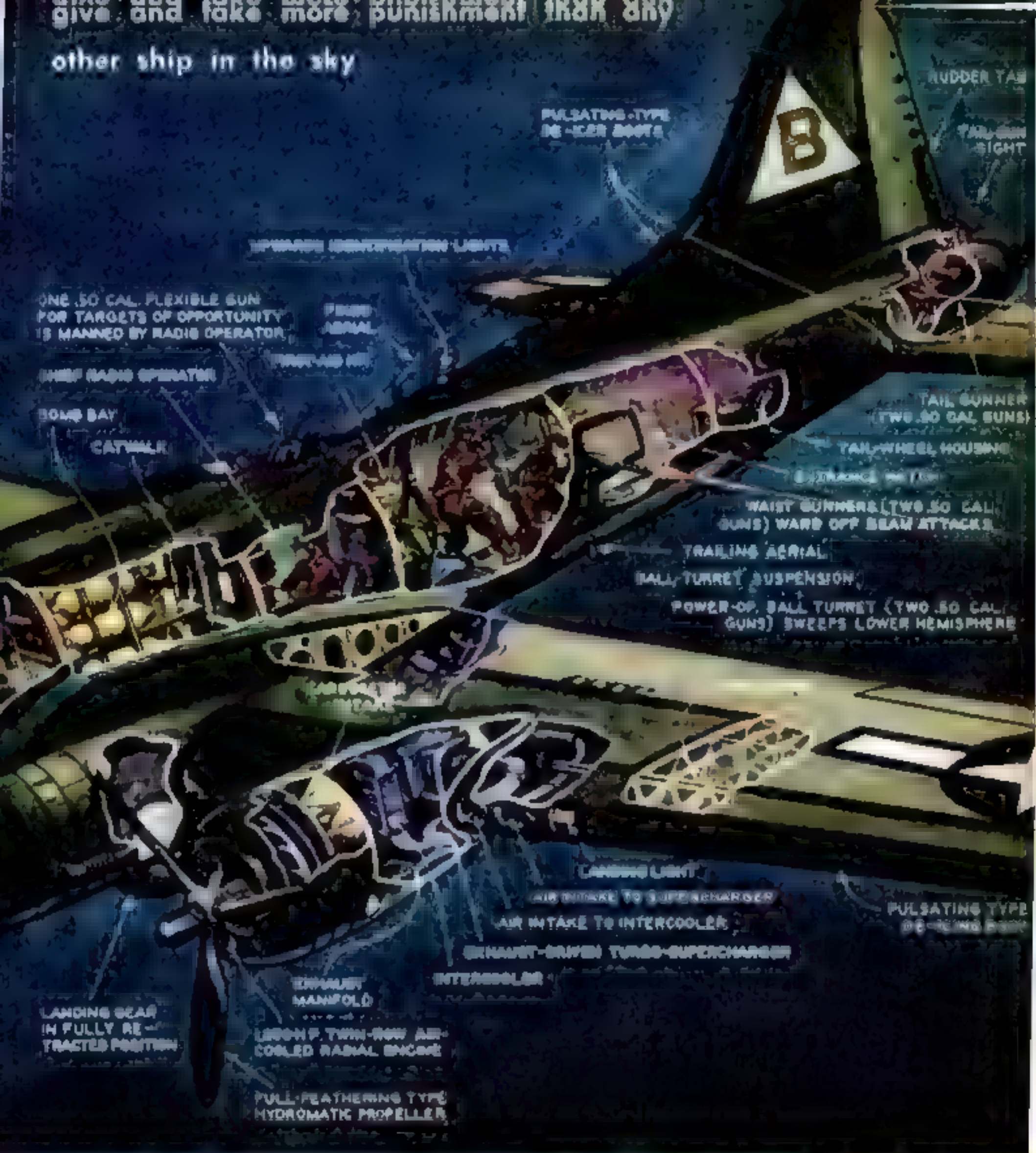
WHAT MAKES THE FLYING FORTRESS SO TOUGH?



WHEN a Fortress flies home from a raid so riddled that daylight shines through at every angle, it isn't a magic charm that holds it together. It's a heritage it has received from a distinguished line of ancestors reaching all the way back to the Boeing Monomail of 1930. From this ship the Fort gets its countersunk rivets, retractable landing gear and the smooth, rigid-stressed skin that enables a

give and take more punishment than any

other ship in the sky



plane's outer shell to carry a large part of the bearing load. Its high speeds have been inherited from the B-9, or Boeing Death Angel, which shamed the biplane fighters of 1931 out of the sky with its pursuit-speed performance. From the commercial Boeing 247's, many of which are still going after 11 years of service, it received a family tradition of longevity. And from the B-15 it has inherited its four engines.

Another secret of the ship's stamina is

the decentralization of stress. The fuselage, for instance, has 74 transverse members, varying in weight from tiny circumferentials to big, main bulkheads. Across these are riveted reinforcing stringers, and over all is a riveted skin of aluminum. The same is true of the wings, fin, and stabilizer. It is this type of construction that makes it possible for one part of the ship to be blown to smithereens while an adjacent part remains intact.



These skulls are wearing two of the more than 30 new bone-setting appliances developed by Capt. Joe Freeman, Canadian dental surgeon. Made from the plastic windows salvaged from wrecked Canadian training planes, these splints are being used to mend the broken facial bones of the flyers who were injured in the crack-ups



The splints are composed of Perspex, a plastic that is easily shaped under warm water, and then quickly regains its rigidity once it has been permitted to dry

SPLINTS made from the plastic windows salvaged from cracked-up Canadian training planes are being used to mend the broken facial bones of the very flyers who have been injured in the crashes. Seeking a substitute for war-scarce metal, Capt. Joe Freeman, dental surgeon of Winnipeg, Canada, discovered that Perspex, a Canadian plastic, could be easily shaped under water, and that it becomes as firm as metal as soon as it has dried. Besides being lighter to wear than all-metal bone-setting appliances, the new splints are much less expensive to manufacture and can be quickly "tailor-made" for unusual types of fractures. Freeman has professionally announced his discovery through the Canadian and American dental journals.

SYNTHETIC RUBBER SPONGE that is said to compare pretty well with the crude-rubber sponge of prewar days, is now being manufactured in three grades—firm, medium, and soft—by the B. F. Goodrich Company, Akron, Ohio. Intended as a general-purpose product, the new rubber can be issued in slabs, cord, tubing, or practically any other molded shape, and is reported to be highly resistant to oil and grease. Looking like black piano keys, the samples at right show the respective resilience of the three grades when pressed by the fingers with approximately the same force.



Are Big Cities "Ugly Monsters?"



By FRANK ROWSOME, Jr.
Drawings by TED KAUTZKY

MOST large cities are rotten to the core, according to Dr. Martin Wagner, a distinguished German architect who was, before Hitler, a city planner for Berlin, Hamburg, and Wilhelmshaven. Now a professor at Harvard, he describes modern cities as "mammoth monsters of ugliness, inefficiency, and distortion."

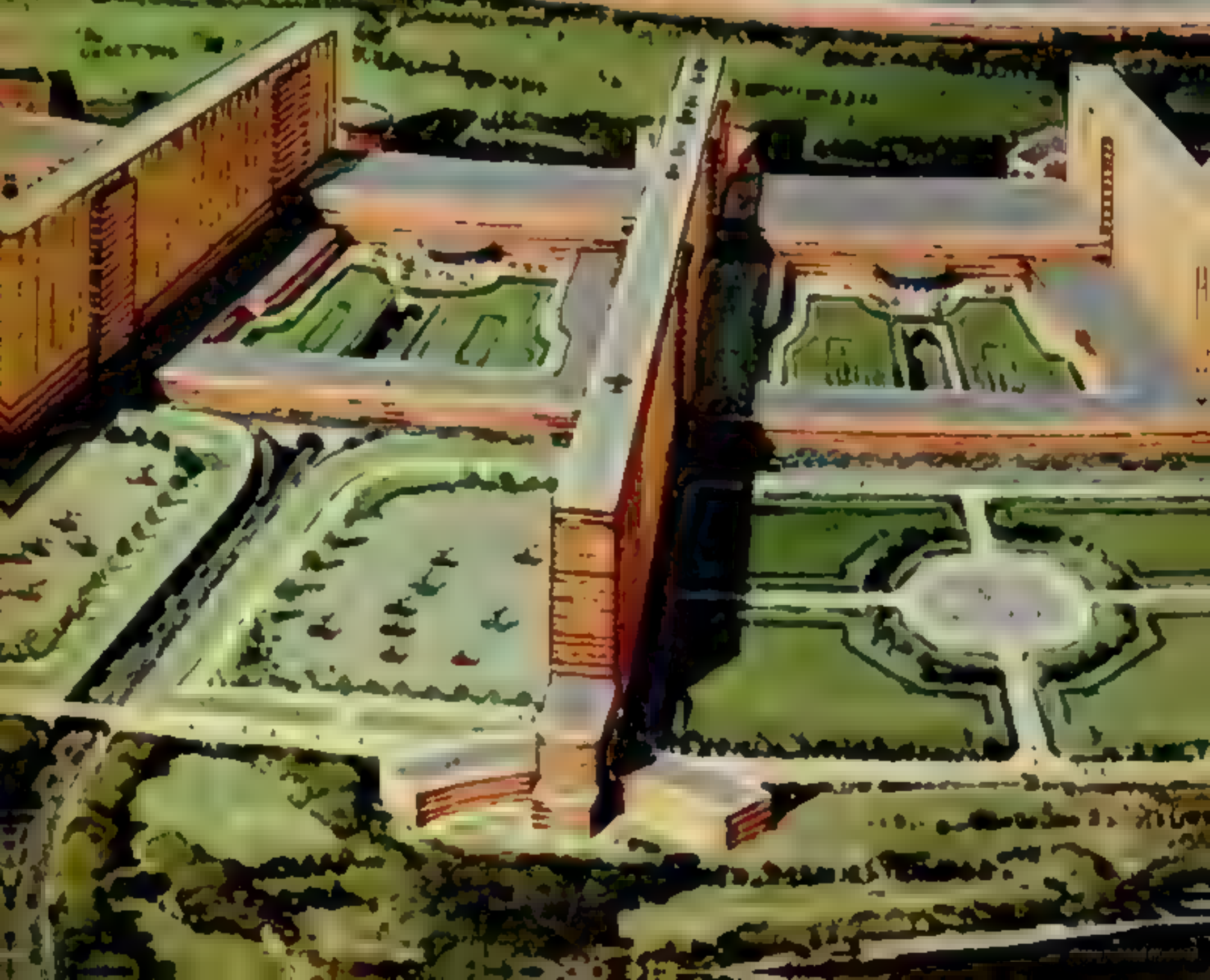
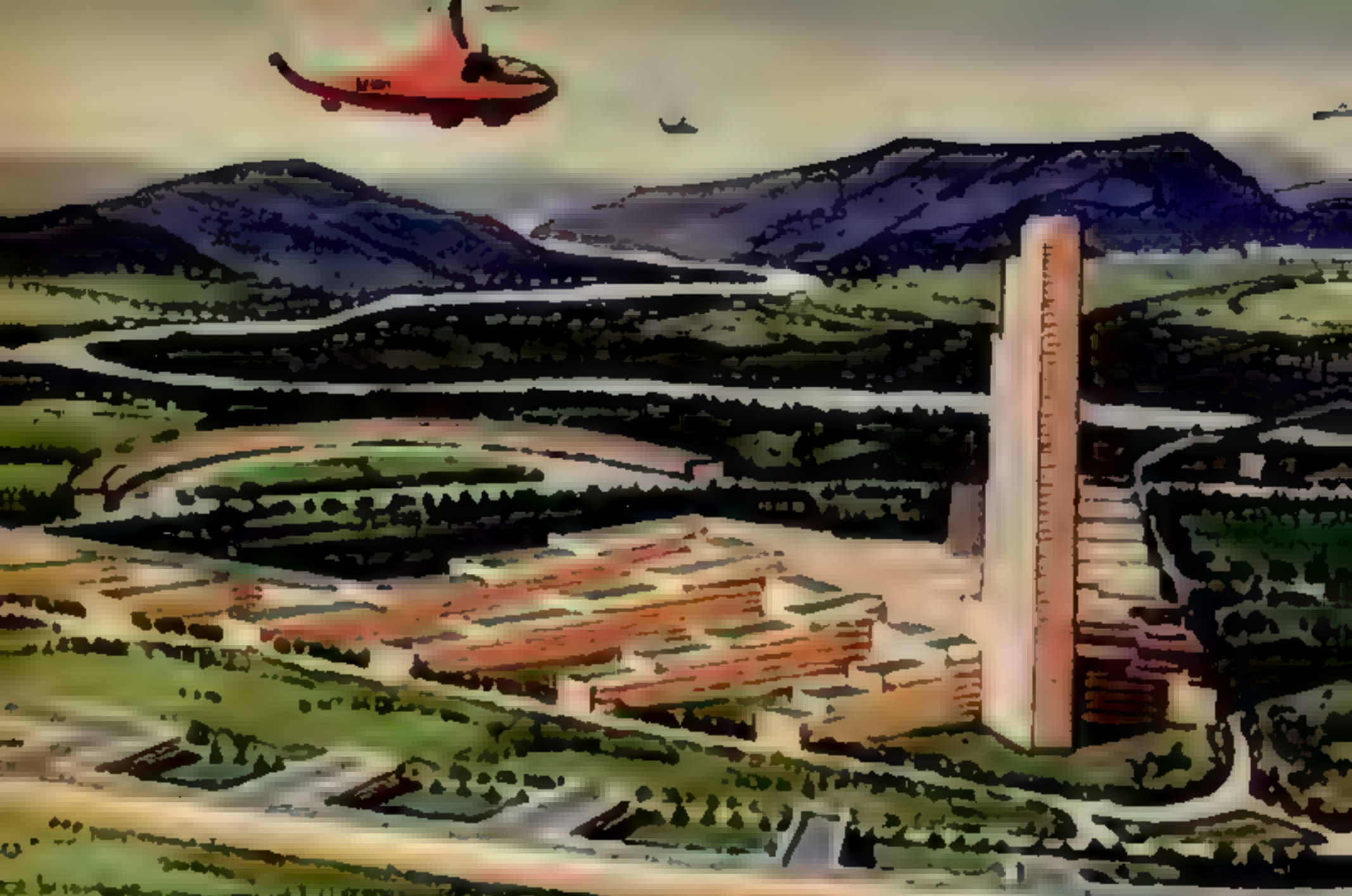
Slum clearance, to his mind, is about as hopeless as trying to stem a tide with a teacup. The root of the difficulty lies in archaic city patterns, which were usually influenced by such factors as horse-drawn traffic, water power, and wood or stone as structural materials. Patching up a present-day city, Dr. Wagner feels, is like trying to

Slum clearance is powerless to stop decay at the core of a city, says a famous architect. Since the trouble is obsolete city design, the answer may be to rebuild from the ground up.

change a stagecoach into a plane by repairing its decayed parts.

A city built from the ground up today might be a breath-taking metropolis - Buck-Rogers-like in effect and yet within reach in details. On pages 104 and 105 is a drawing that shows Dr. Wagner's ideas of a city created specifically for modern living.

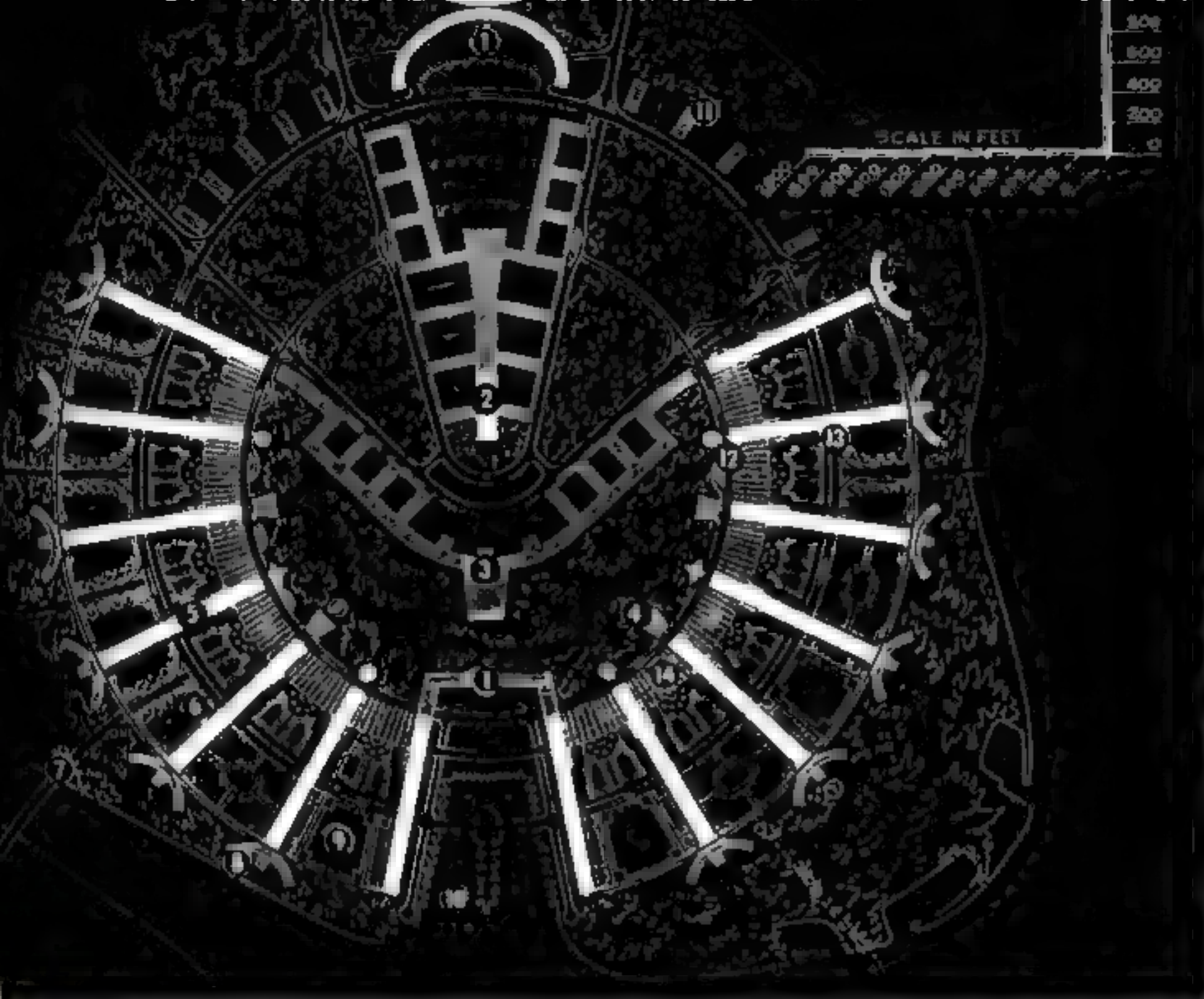
Only a small percentage of the daytime population lives in the city itself. Most citizens live in small, country communities, and reach the city by high-speed train, express highway, or private helicopter. No manufacturing is done within the city, since industry is dispersed, near its raw materials and power. The city is entirely a center where people gather to do business, purchase goods, and go to schools or hospitals, movies or [\(Continued on page 106\)](#)



IN OUR LIFETIME
A CITY LIKE THIS
is entirely possible, city
planners say, if we make
a fresh start instead of
trying to patch up decay.
Shown at the right is a
key for locating features
in this city center.

1. Railroad and bus terminal, connected with a peripheral
way system. 2. Governmental buildings. 3. Permanent hall
for art, science, and fashion exhibitions. 4. Bar, theater, restau-
rant, and movie house. 5. Office building with plane-landing
facilities on the roof. (One such building is always upwind.)
6. Landing area for helicopters with parking space beneath.
7. Feeder road from suburban districts; the city has only a mass
overnight population. 8. Resort hotels. 9. Terrace with a car
parking space beneath. 10. Motorboat harbor with facilities for
handling passengers and mail from seaplanes and steamships.





IN THE MASTER PLAN FOR THE COMING CITY, space for uncramped growth must be provided to avoid the same congestion and inefficiency that are now bringing a blight upon many downtown districts. In addition to easy access and unhindered traffic flow, planners must supply extensive parking areas, probably for helicopters as well as cars. Continuing the identification key begun on the preceding page: 11. Concert halls, clubs, and buildings for scientific and cultural associations. 12. Circular, sunken feeder highway for clockwise city traffic. 13. Highway for counterclockwise traffic flow. 14. Department stores and shops, linked by inclosed pedestrian promenades.

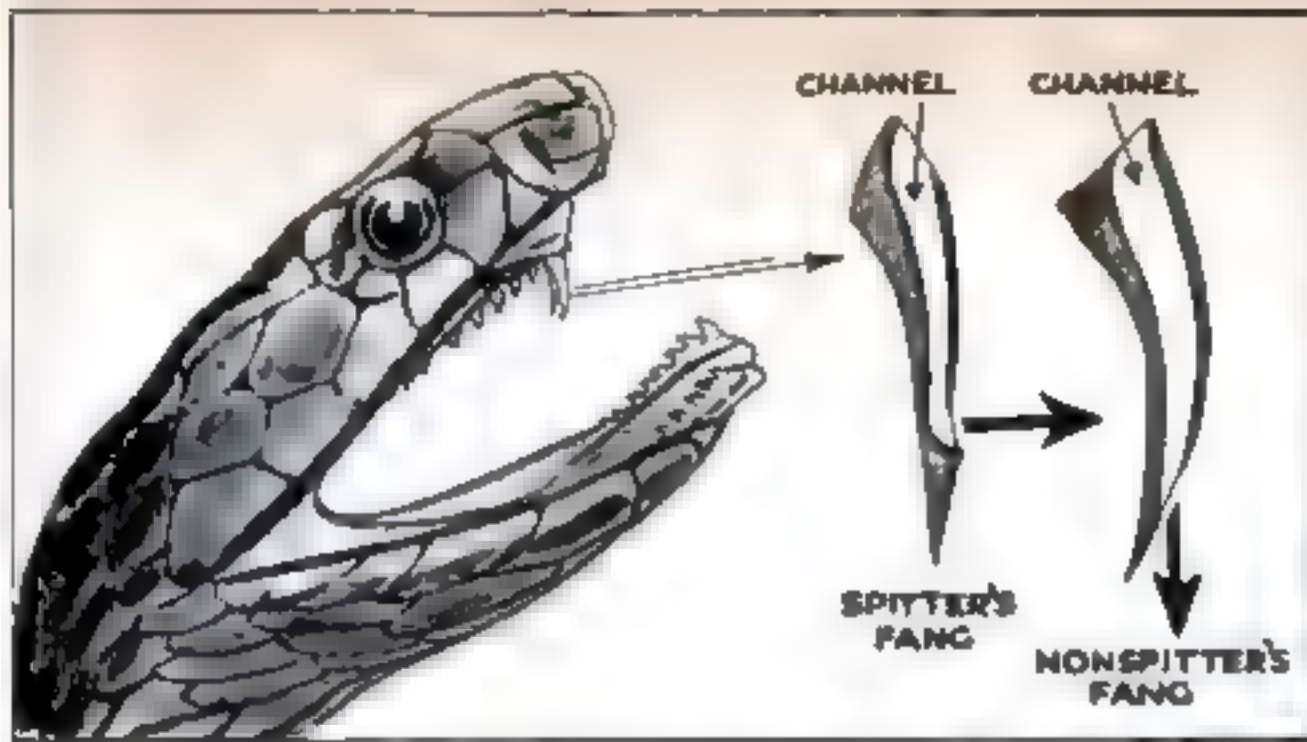
museums, and restaurants or concert halls.

Two sunken highways encircle the city which also has a series of spokelike feeder roads, a subway loop, and two train and bus terminals on opposite points of the rim. All traffic is carefully engineered to avoid funnels or focal points of congestion. Extensive parking areas— for helicopters as well as cars— lie beneath the terraces between buildings, so that a person can drive or fly directly to his destination, leaving his vehicle near by while he transacts his business.

Radiating from the tall government structure in the center are 20-story office buildings, 1,200 feet long. Since one is always heading into the wind, their roofs are

equipped like carrier decks to land transport planes. Permanent exhibition halls of science and art are located toward the center, as are theaters, bars, and restaurants. Retail stores, with closed-in pedestrian promenades, form the inner circle of buildings.

More than just another dreamy world-of-tomorrow, Dr. Wagner's complete plans will withstand careful scrutiny. He's quick to concede that the city might take more daring— and capital— on the part of its builders than they may possess. He admits that his concept can be criticized as over-formal. But for skeptics, Martin Wagner has a quotation: "Make no little plans, they have no magic to stir men's blood."



SCIENCE FINALLY DISCOVERS *How the Cobra Spits*

SOME cobras spit their deadly venom, while others transmit it only by biting. Studies by Charles Mitchill Bogert, curator of reptiles at the American Museum of Natural History, have just revealed (upper drawing) that the fang formation governs the cobra's aptitude as a spitter or a non-spitter. Both types of fangs work like a hypodermic needle, but only the fangs with the cavities in front can eject venom across an open space. Spitting cobras aim for their victims' eyes, and have made hits at from six to 12 feet. Temporary blindness, followed by inflammation, is the usual effect on humans.

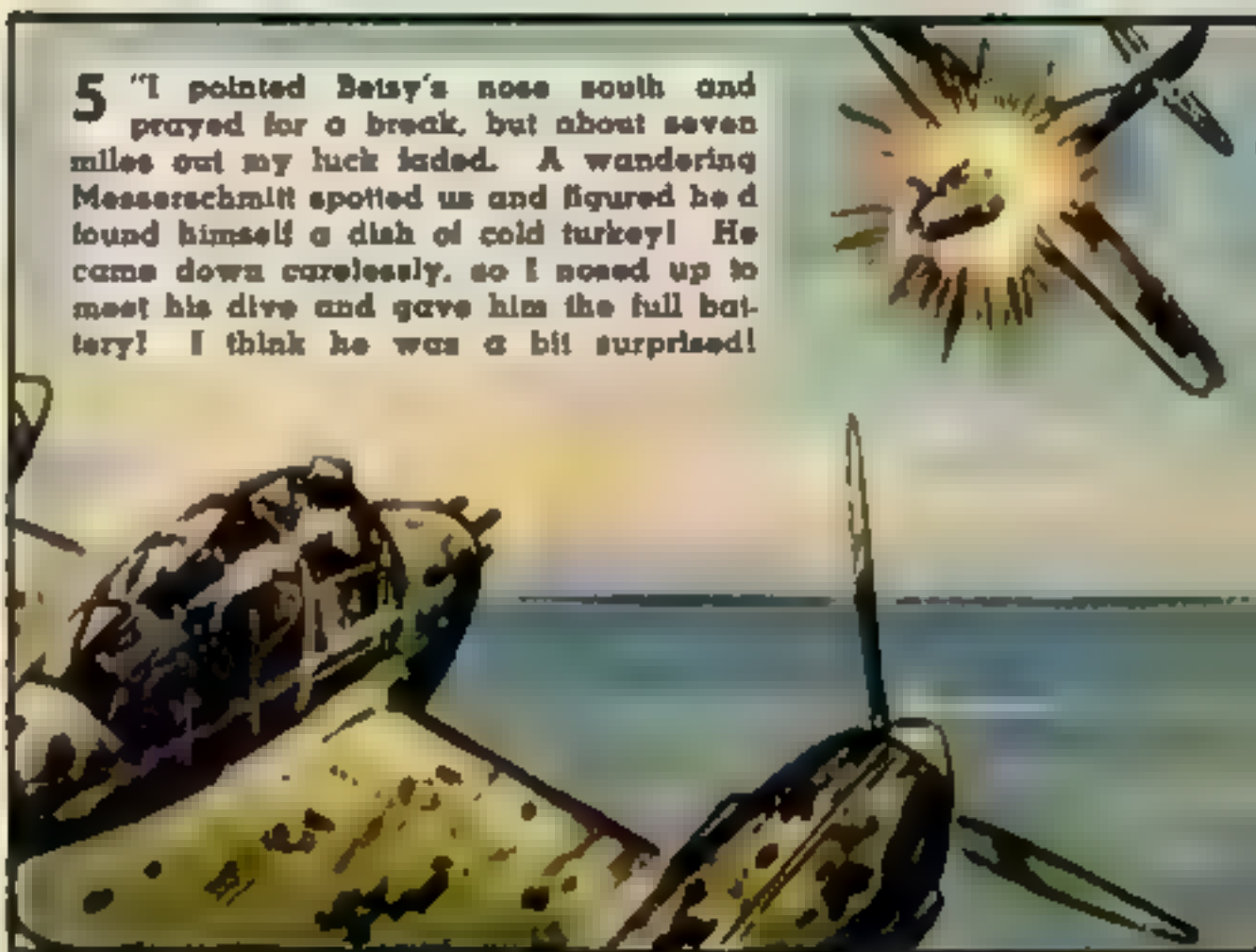
Lightning's One-Engine



High over Italy, Lt. Lester H. Laird, of the Northwest African Air Force, was flying a combat mission with his Lightning squadron when Old Man Trouble tapped at his cockpit window. . . .



"When the smoke cleared, I leveled off and found that the unbalanced engine was pulling us around in a flat turn. The trim tabs were busted, so I had to shove with both feet on the rudder pedal to keep a straight course. As we crossed the coast, Jerry ack-ack opened up, but we were going too fast.

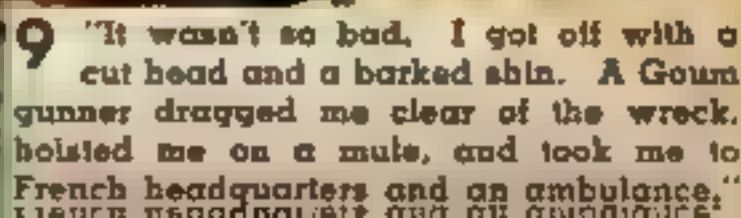
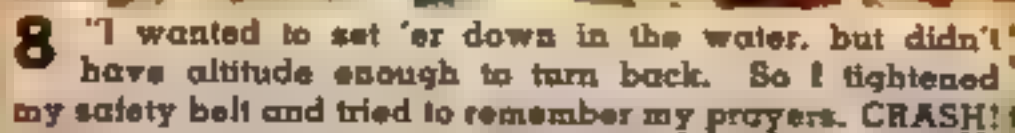
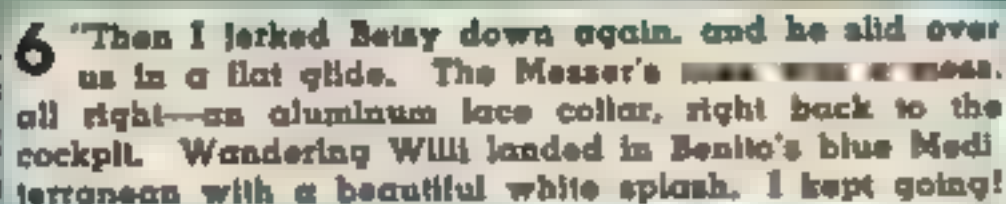
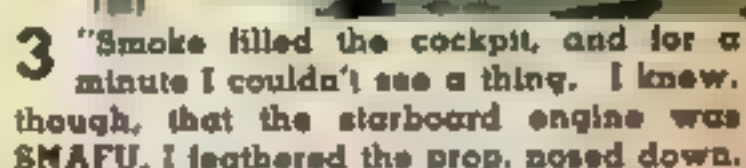
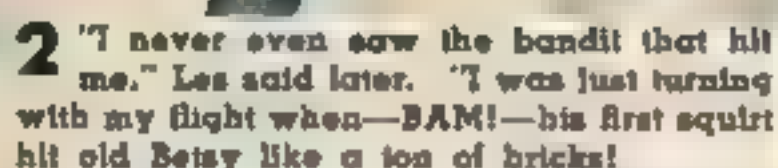


5 "I pointed Daisy's nose south and prayed for a break, but about seven miles out my luck faded. A wandering Messerschmitt spotted us and figured he'd found himself a dish of cold turkey! He came down carelessly, so I nosed up to meet his dive and gave him the full battery! I think he was a bit surprised!



"All this heaving and hauling hadn't done my remaining Allison any good. Over the African coast she froze her bearings and fixed out on me!

and with one engine dead, "Les" Laird of Louisiana proved that Lockheed's P-38 twin-tailed terror is no soft touch for Axis cripple-killers.

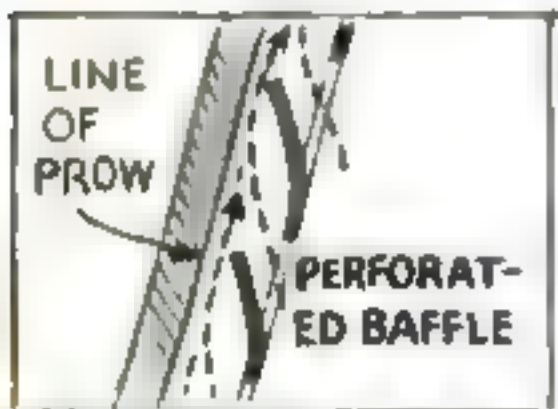




IT WILL BE A PLEASURE to give a child medicine with this spoon that releases its contents only when the person administering the dose draws back a slide

on top of the bowl. The liquid is then easily poured into the patient's mouth. The inventor is Joseph P. Takach, of West New Brighton, N. Y.

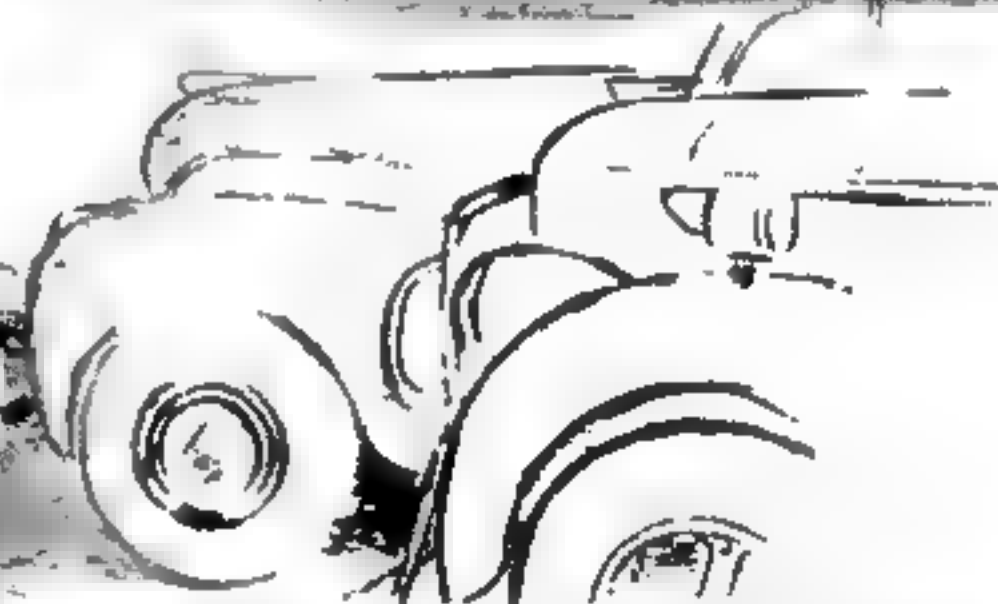
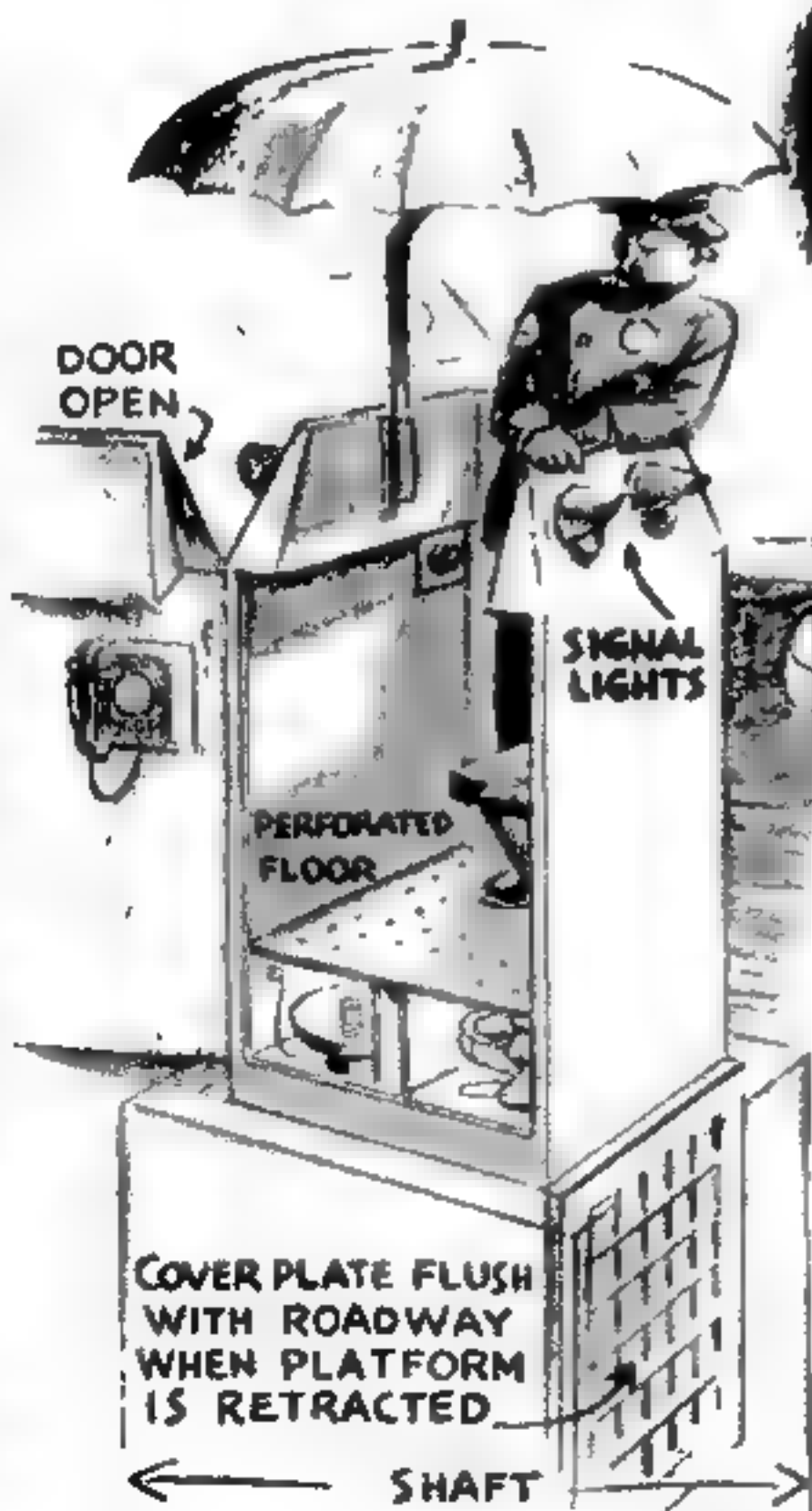
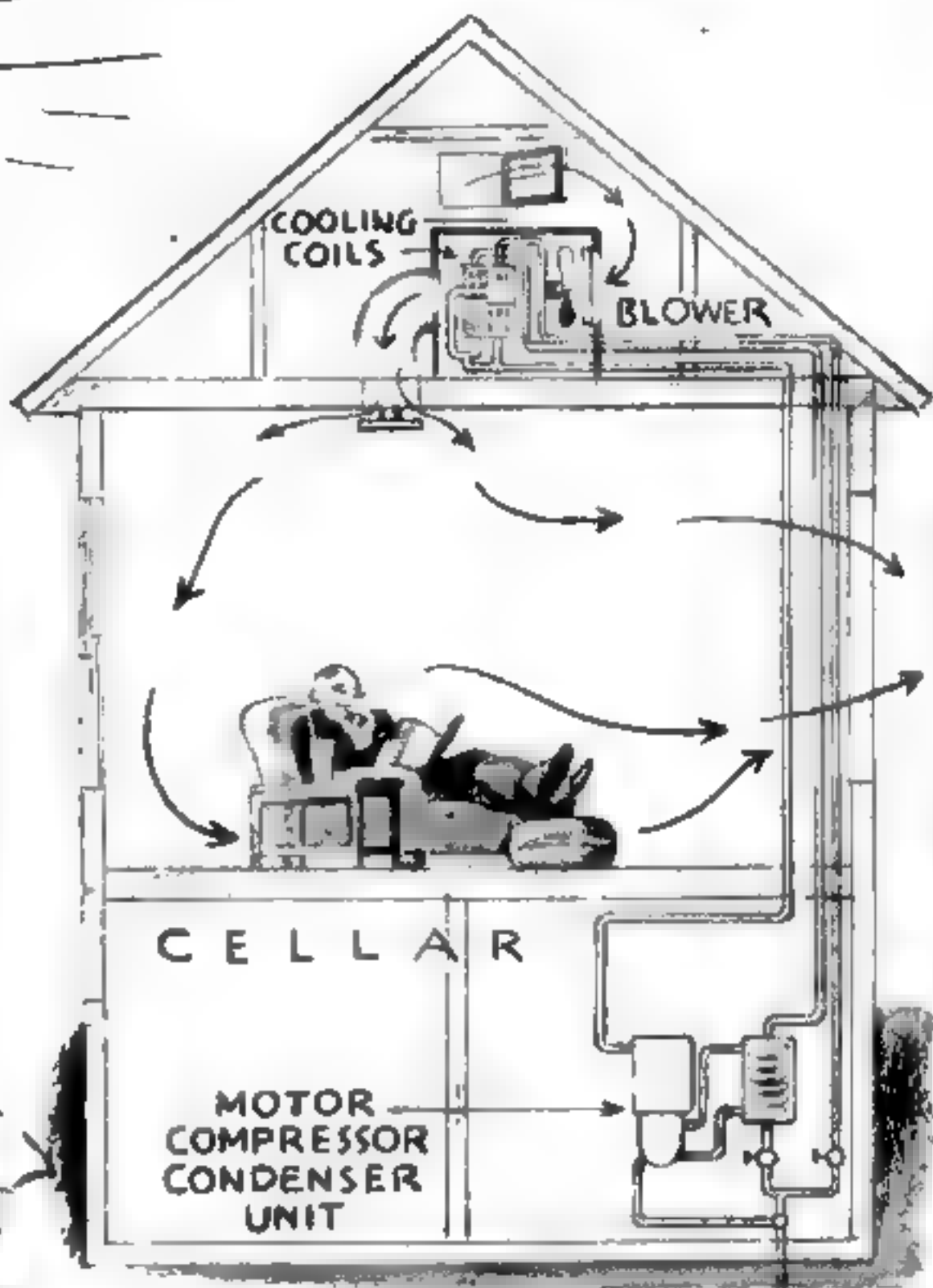
LAZY-TONGS principle has been employed by Benjamin Janowsky, New York City, in developing a new type of umbrella that will fold into small space but will be smooth and rigid when opened. The handle rod is in four sections, which telescope toward the largest at the top. After the rod is extended, the umbrella may be easily opened by applying pressure to the axis ends of the ribs, thereby extending them and stretching out the folded fabric in a smooth cover.



A SHOCK ABSORBER for small high-speed boats consists of a perforated metal shield fixed a short distance ahead of the bow. As the boat gets the impact of waves, holes in the shield conduct jets of water toward the stern through short tubes acting as baffles. William Waller, Jr., Chicago, is the originator.



A MIDGET AIR-COOLER for small homes, with the heavy motor-compressor in the basement and a simplified lightweight cooling coil and blower in the attic, has been devised by Richard E. Gould, Oakwood, Ohio. The refrigerating unit down cellar cools city water, which is piped to a cooling coil in the attic, from which the chilled air is forced to flow downward through stairways and halls. Slightly opened windows will assist in the distribution if it is necessary.



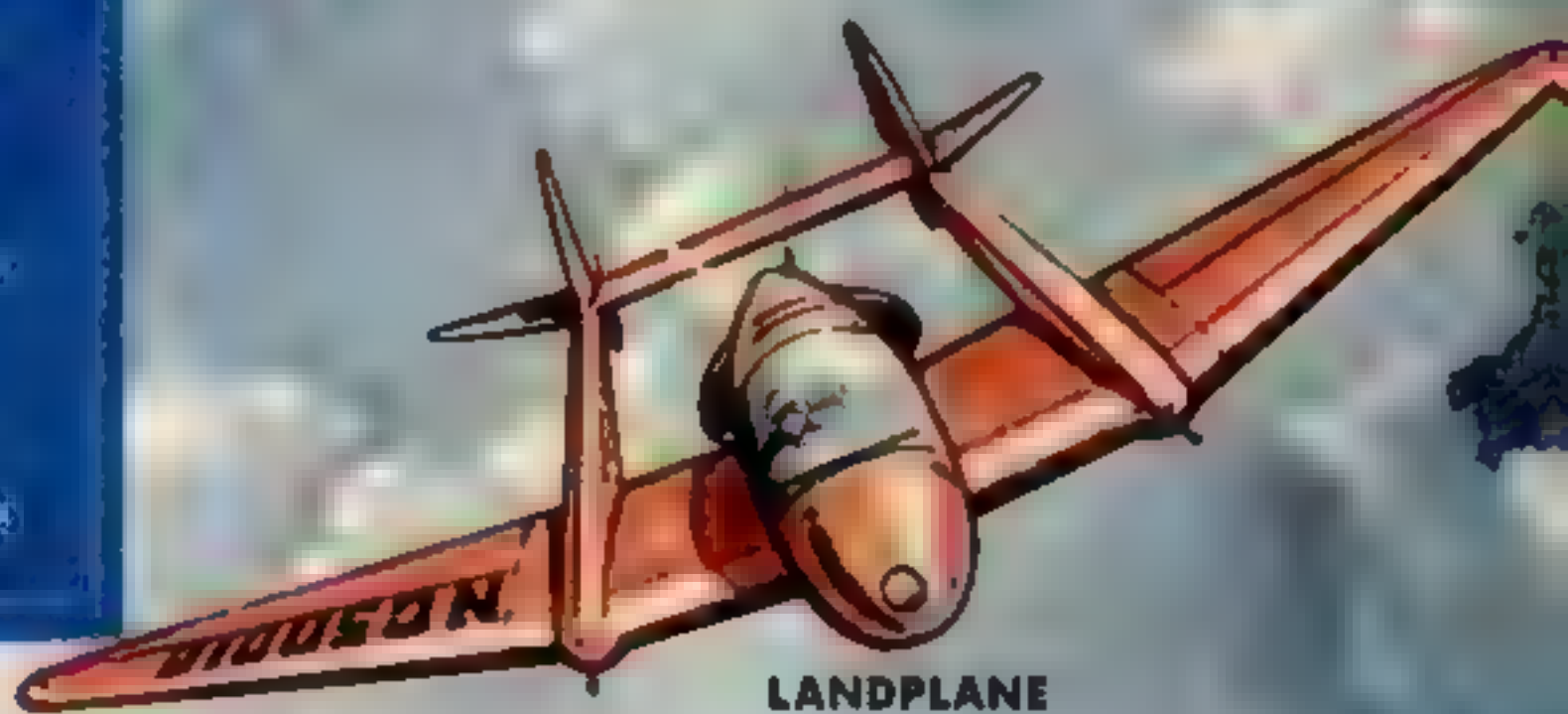
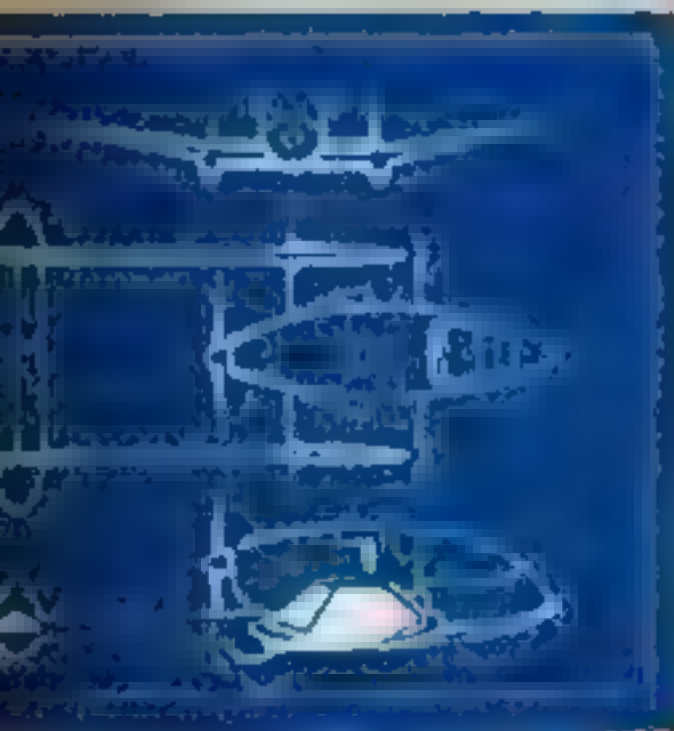
HERE-TODAY, GONE-TOMORROW traffic-signal stand embodies a counter-weight mechanism for lowering it into a pit directly below when it is not in use. Electrical equipment includes traffic lights, both automatic and hand-operated, telephone, heater, and a blower fan. When traffic is light, the platform is retracted, and a cover plate is lowered flush with the pavement, leaving no obstruction to cars that may cross the spot. The inventors are Luis and Angel Canepa, Santiago, Chile.

THESE ARE *Eric SLOANE'S* IDEAS
FOR PRIVATE PLANES OF THE FUTURE

What Are Your Ideas?



FLYING BOAT



LANDPLANE



AMPHIBIAN

\$5,000 CONTEST

The Plane You'd Like to Own

All you have to do is write a letter describing what you think the postwar air flivver should be like . . . Everyone has a chance to win one of the many War Bond awards . . . There's a separate advanced class, too, for aviation experts.

AWARDS TOTAL \$5,000 IN TWO SEPARATE CLASSES

PROFESSIONAL

For Aviation Engineers, Designers,
Pilot-Engineers

FIRST PRIZE . . . \$1,000 War Bond
SECOND PRIZE . . . 500 War Bond
THIRD PRIZE . . . 300 in War Bonds
FOURTH PRIZE . . . 200 in War Bonds
FIFTH PRIZE . . . 100 War Bond
SIXTH PRIZE . . . 50 War Bond
SEVENTH to
TWENTIETH PRIZES
\$25 War Bond each . 350 in War Bonds

NONPROFESSIONAL

For
General Readers

FIRST PRIZE . . . \$1,000 War Bond
SECOND PRIZE . . . 500 War Bond
THIRD PRIZE . . . 300 in War Bonds
FOURTH PRIZE . . . 200 in War Bonds
FIFTH PRIZE . . . 100 War Bond
SIXTH PRIZE . . . 50 War Bond
SEVENTH to
TWENTIETH PRIZES
\$25 War Bond each . 350 in War Bonds

WOULD you like to have a chance to help plan the private plane of the postwar period? Are you willing to take a little time to think about the kind of plane you yourself would like to own and fly after the war is won? If so, POPULAR SCIENCE MONTHLY will welcome your suggestions. Send them in, and, to make it worth your while and encourage friendly competition, we shall award \$5,000 in War Bonds as prizes for the best ideas received.

As you will see from

the list of awards above, contestants will be divided into two classes—professional and nonprofessional. From the general reader—the average man who has a keen interest in aviation, but no specialized knowledge of aircraft design—we ask nothing more than a letter, not to exceed 1,000 words in length, telling us as plainly and simply as possible

what kind of plane he thinks would be best suited for private use after the war. Sketches or diagrams may be added. If
(Continued on page 115)

"Within four years of the end of hostilities we shall have, I believe, some 300,000 civilian planes in active service. At the time of Pearl Harbor our licensed civilian aircraft numbered less than 25,000."—Charles I. Stanton, Administrator of Civil Aeronautics.

Rules

THE purpose of this contest is to encourage interest in aviation in general and aircraft design in particular through serious consideration of America's private planes of the future. For the purpose of this contest the helicopter may be regarded as a private plane.

Contestants will submit their ideas as to the appearance, size, equipment, and performance of the private plane that would find the greatest postwar market among the thousands of prospective pilot-owners.

The contest is open to all except employees of Popular Science Publishing Co., Inc., and their families. Entries will be divided into two classes. The professional class will be open to those who have had training, or who are now receiving training, in aviation engineering, aircraft design, or aircraft drafting, or who are now employed or have had experience in any of these three types of work. The nonprofessional class will be open to all others. Members of the nonprofessional class may submit entries in the professional class if they wish, but professionals will be limited to the professional category. Only one entry may be submitted by a contestant. Identical prizes will be awarded in both classes.

Professional-class entries will consist of at least a "three-view" drawing (front, top, and side elevations) of the proposed future private plane plus a descriptive letter of not more than 1,000 words about the plane and its theoretical performance, dimensions, equipment, and so forth.

Nonprofessional entries will consist of a letter of not more than 1,000 words describing the proposed plane. If desired, you may include a sketch or drawing of the plane in pencil or other medium.

Entries will not be judged upon writing ability, craftsmanship, or decorative appearance. Only the soundness, practicability, originality, and merit of the ideas will count. Nonprofessional entries must be accompanied by a signed statement that the contestant has never been employed in, has not had training in, and is not now receiving training in aviation engineering, aircraft design, or aircraft drafting.

Entries should be mailed flat and must be fully prepaid. Each entry must be plainly marked with your name and address and the class in which the material is to be entered. (Please typewrite or print this information on each item or page of your entry.) Also state your occupation and the position held. Address Plane Contest Editor, Popular Science Monthly, 353 Fourth Ave., New York 10, N. Y. The contest will close Saturday, September 30, 1944, and all entries must be postmarked on or before that date.

All prize-winning entries will become the property of Popular Science Monthly for publication. However, contestants will retain the right to make any commercial use of their designs they wish. No entries will



ERCOUCPE. A low-wing, two-seat monoplane with twin rudders, this all-metal job has a simplified control system and is incapable of spinning. Has top speed of 117 m.p.h., range of 350



CULVER CADET. This exceptionally "clean" plane with a top speed of 140 m.p.h. requires rather expert handling. Landing gear is manually retracting, construction is plastic-plywood

MONOCOUCPE. This two-place, side-by-side cabin ship with a high wing has a top speed of 140. Note wheel pants on fixed landing gear. The steel-tubing construction is strut-braced

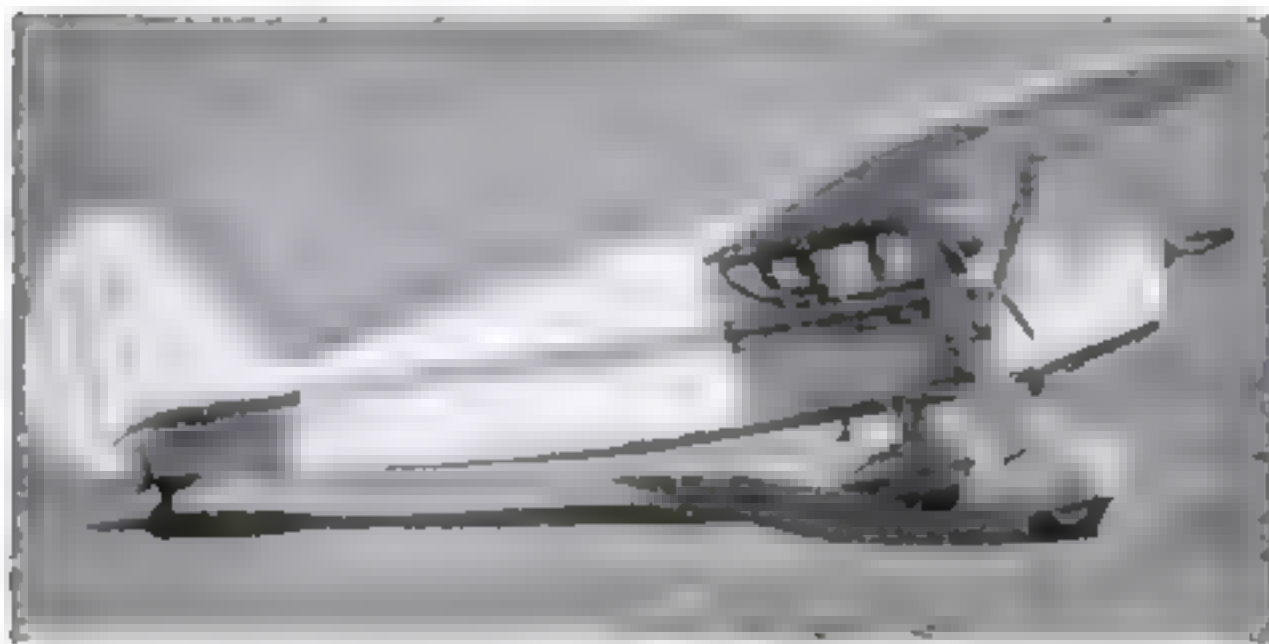


be returned, so make a copy of your entry or have it photostated if you want to keep it for future reference.

The judges will be a group of prominent aviation authorities and the editors of Popular Science Monthly. The list will be announced before the close of the contest. The decision of the judges will be final. In case of ties, the tying contestants will receive identical awards. All contestants will be informed by mail as to the winners as soon after their selection as possible.



SKYFARER is a two-place ship, taxis like a car, has excellent visibility, and is nonspinnable. It is banked by ailerons, has landing flaps, one-wheel control, and a range of 400 miles.



FAIRCHILD "24" is a four-seater cabin ship well equipped with instruments and capable of 150 m.p.h. It has inverted air-cooled engine, hydraulic brakes, and automatic starter.

PIPER CRUISER has top speed of 95. Two passengers sit side by side behind pilot. A rugged ship, it carries all the standard instruments, and has a cruising range of 425 miles.



you consider them necessary or desirable.

In the professional class, which is for those who have had training in aviation engineering, aircraft design, or aircraft drafting, we ask a little more. Besides a letter, we should like each contestant in that class to submit at least a general assembly or "three-view" drawing of the front, top, and side elevations of the plane he wishes to en-

ter. The whole purpose is to make the contestant's idea as plain as possible to the judges.

In both classes, the only question a contestant need ask himself is, "Have I made myself perfectly clear?"

In other words, this is a competition of ideas. Flowery words, ornate drawings, and embellishments will be disregarded entirely by the judges, who will consider only the basic merit, originality, and utility of each contestant's suggestions.

Before you start to prepare your entry, read the contest rules carefully. Then note the check list and drawings that have been prepared to help you in working toward a sound, practical solution to the problem of planning the plane you'd like to own.

Many more aids of a similar type will appear in each issue of **POPULAR SCIENCE MONTHLY** up to the close of the contest. This month the emphasis has been placed upon the conventional type of light plane. In the July issue will appear information on aircraft designing and some suggestions for a tail-first plane, a midget sport plane, and a circular-wing design. In the August issue there will be information on helicopters and more service aids.

If you doubt your ability to visualize a small plane of original design, just make tracings of some of the elements our staff artist, Stewart Rouse, has drawn for your assistance, and try combining them. Rouse, by the way, was formerly a pilot and actually designed and built a plane himself. You'll find that he has laid out the parts in such a manner that they can be assembled in many ways to give a variety of designs.

Here's something else that may help you. A survey on the subject of light planes was recently conducted at the direction

of Oliver Parks, head of Parks Air College, of East St. Louis, Ill., which is one of the best-known schools of its type, and which has long offered college and professional training leading to a B.S. degree in piloting, aviation operations, maintenance engineering, and aeronautical engineering. With the help of a research organization, Parks set out to find the answers to two questions: What will be the postwar market for per-

sonal planes? What sort of personal aircraft will satisfy that market? Thousands of potential private-plane owners in eight states were interviewed. Their ages ranged from 20 to 60 years and averaged 40.

As far as the market is concerned, it will be a big one. On the basis of the Parks survey, 78,000 potential buyers are apparently planning to invest at least \$1,500 each in a private plane as soon as the planes are available after the war. Another 119,000 are interested in owning helicopters when they are perfected for the layman pilot. Another 78,000 are ready to buy planes, but haven't made up their minds as to the types.

Now, you can't possibly suggest any one type of plane that would appeal to all these potential amateur pilots. We're not asking you to. All we want to know is what kind of plane you yourself would prefer.

The Parks sur- (Continued on page 228)

Check List

TYPE OF DESIGN AND CONSTRUCTION

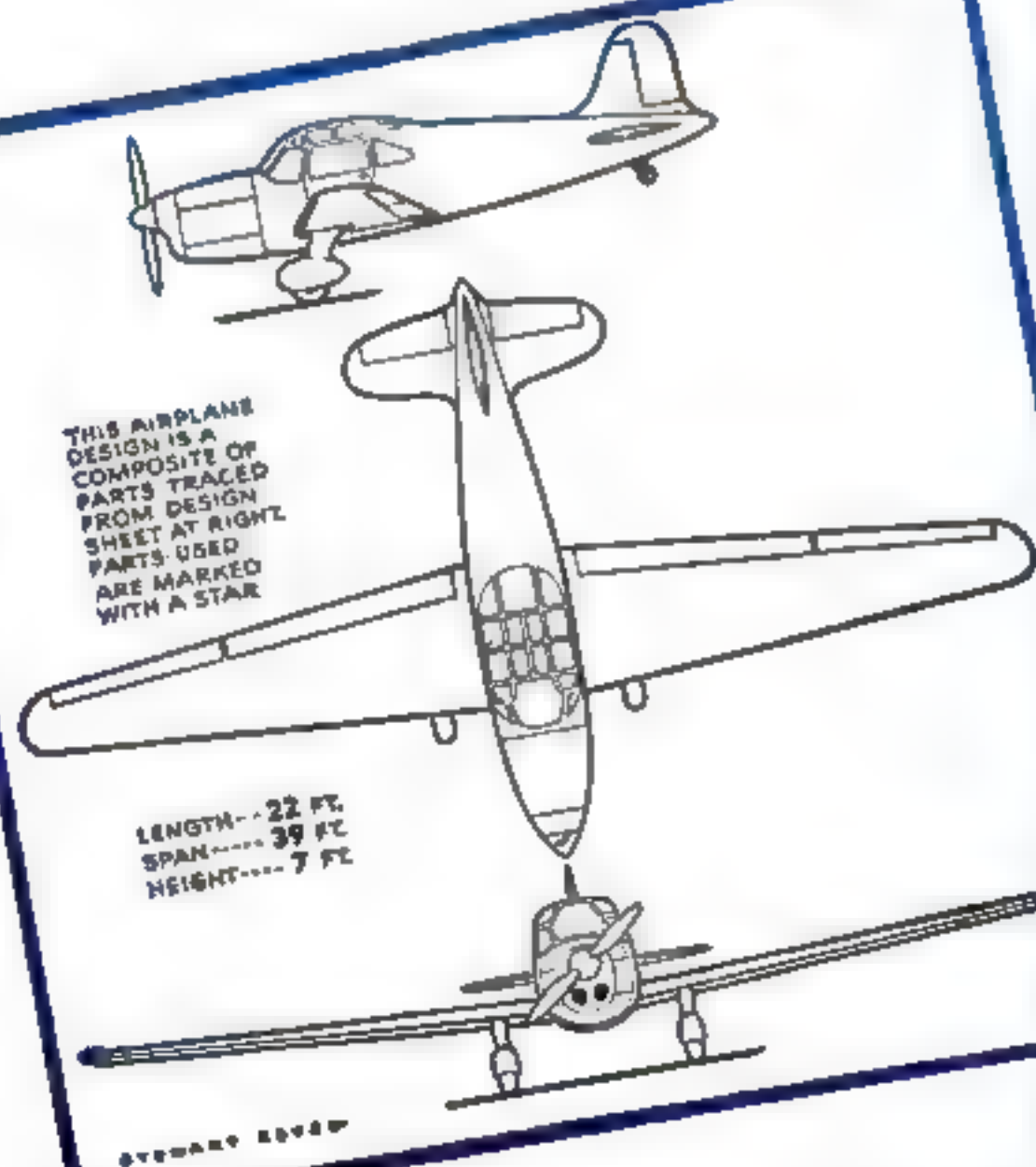
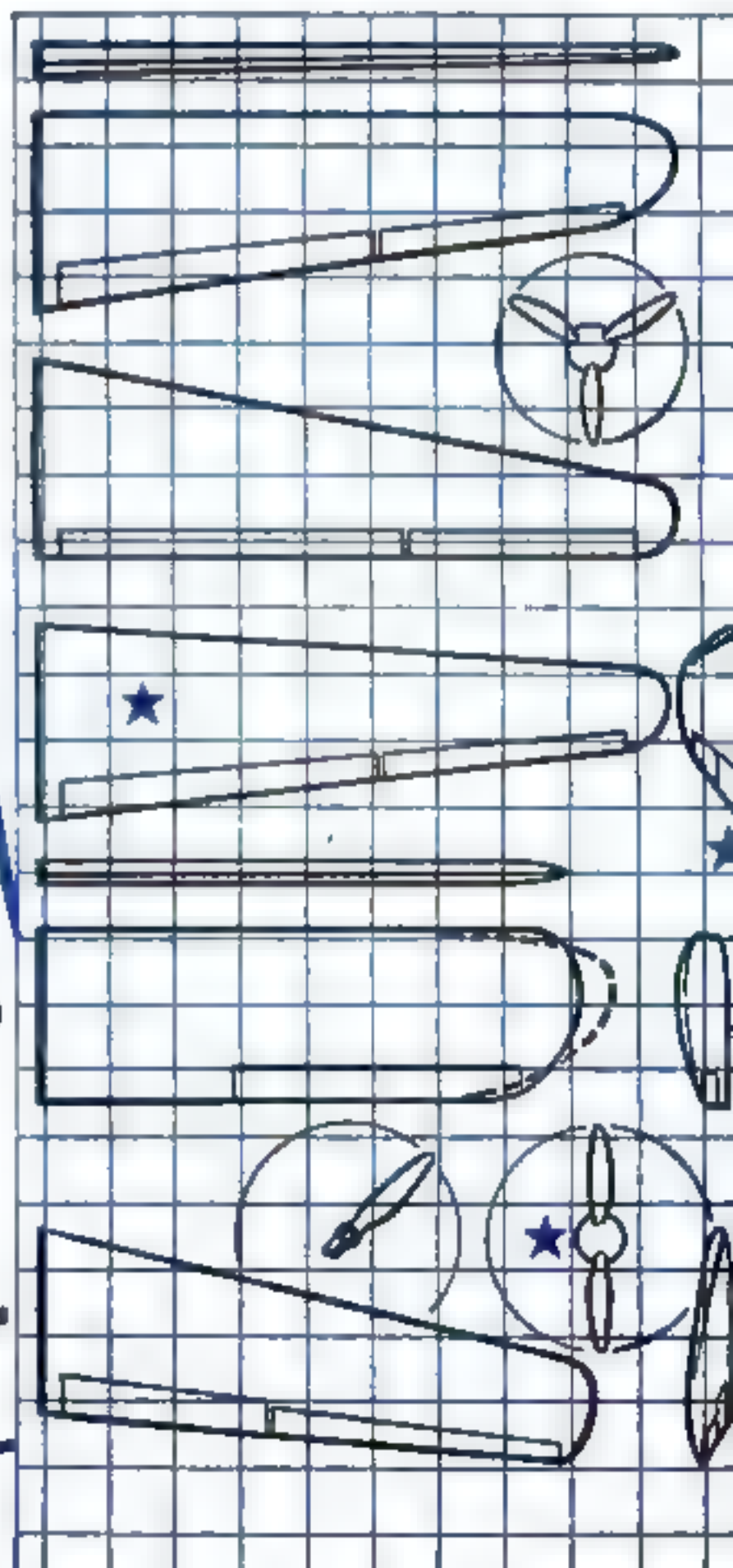
High wing, midwing, low wing, flying wing, open cockpit, cabin model, seaplane, flying boat, land plane, amphibian, helicopter, Autogiro, tailless, roadable with removable wings, plastic, all metal, tandem seating or side-by-side, number of places, nonspinning with single control system, glider-plane combination, biplane, triplane.

WINGS

Tapered, folding, removable, gull, back staggered, swept back, rounded, pointed, square, flying wing, with flaps, spoilers, slots, trim tabs, wingtip ailerons, cantilever or strut braced, laminar flow, circular or disk variable camber, telescoping.

THERE'S NO TRICK TO MAKING A THREE-VIEW DRAWING

TO HELP you visualize your ideas for the future plane you'd like to own, we offer at above right a check list of items to consider when planning your entry. This is meant to stimulate thought on many details that may be included in your entry. Below is a simple "three-view" of a hypothetical plane made up from the "starred" parts at the right. We are primarily interested in your ideas for the future private plane, but if you feel that you can present them more clearly through a "three-view" or other type of sketch, the drawings will be considered equally with other contest material.



ENGINE OR POWER PLANT

In-line, radial, liquid cooled, air cooled, gasoline, Diesel, jet, inverted, submerged in wing, pancake.

LANDING GEAR

Fixed or retracting, tricycle, wheel and skid, standard, automatic or manually retracting, with wheel pants, pontoons, amphibious, skis, wing-tip floats or wheels, wide track between wheels, self-rotating tires, blowout-proof tires, retracting tail-wheel, emergency tail skid for tricycle gear.

PROPELLERS

Single blade, double blade, triple blade, folding blade, variable pitch, automatic pitch, pusher, tractor, driven from shaft, above or below cabin, screened or open, wood, metal, plastic, with or without spinner, disconnecting in case plane is roadable with folding or removable wings.

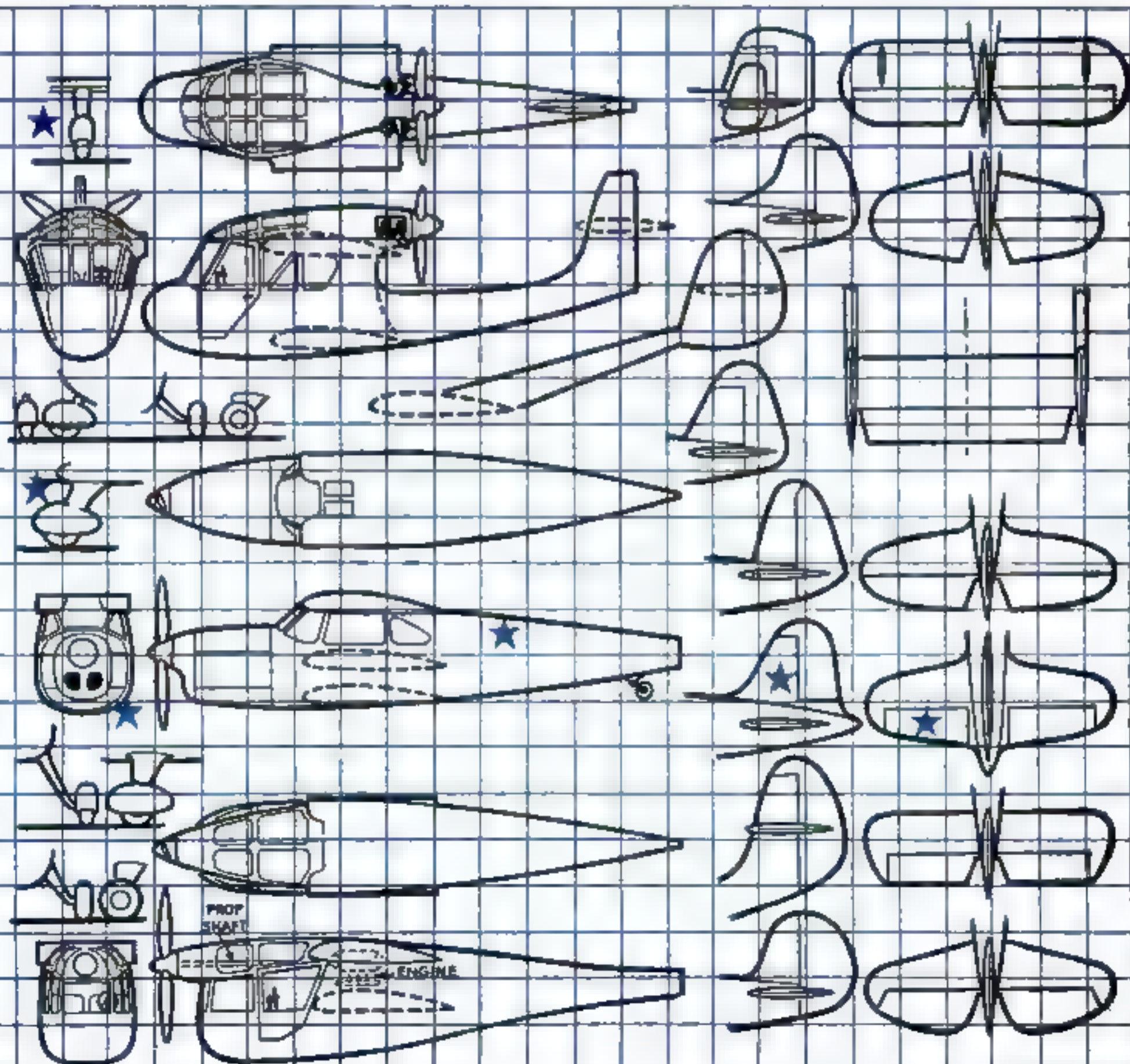
EQUIPMENT

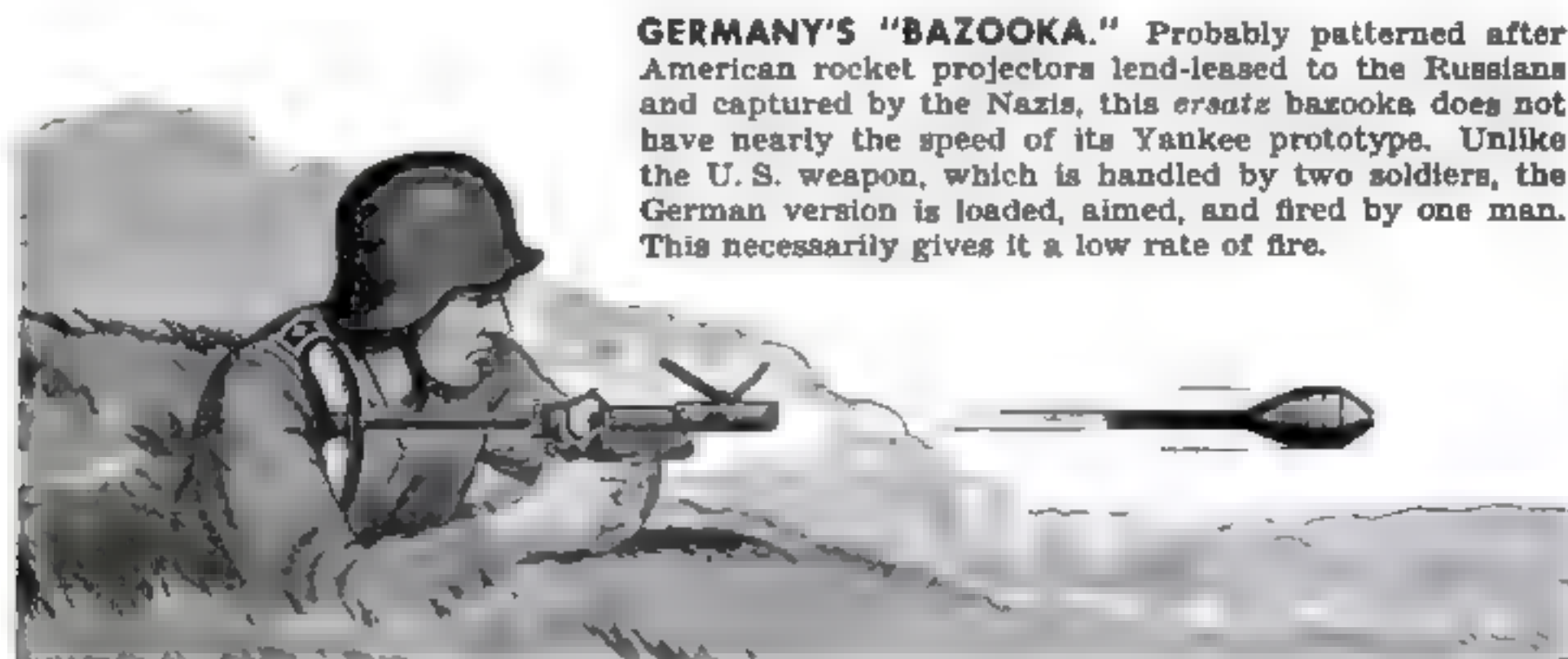
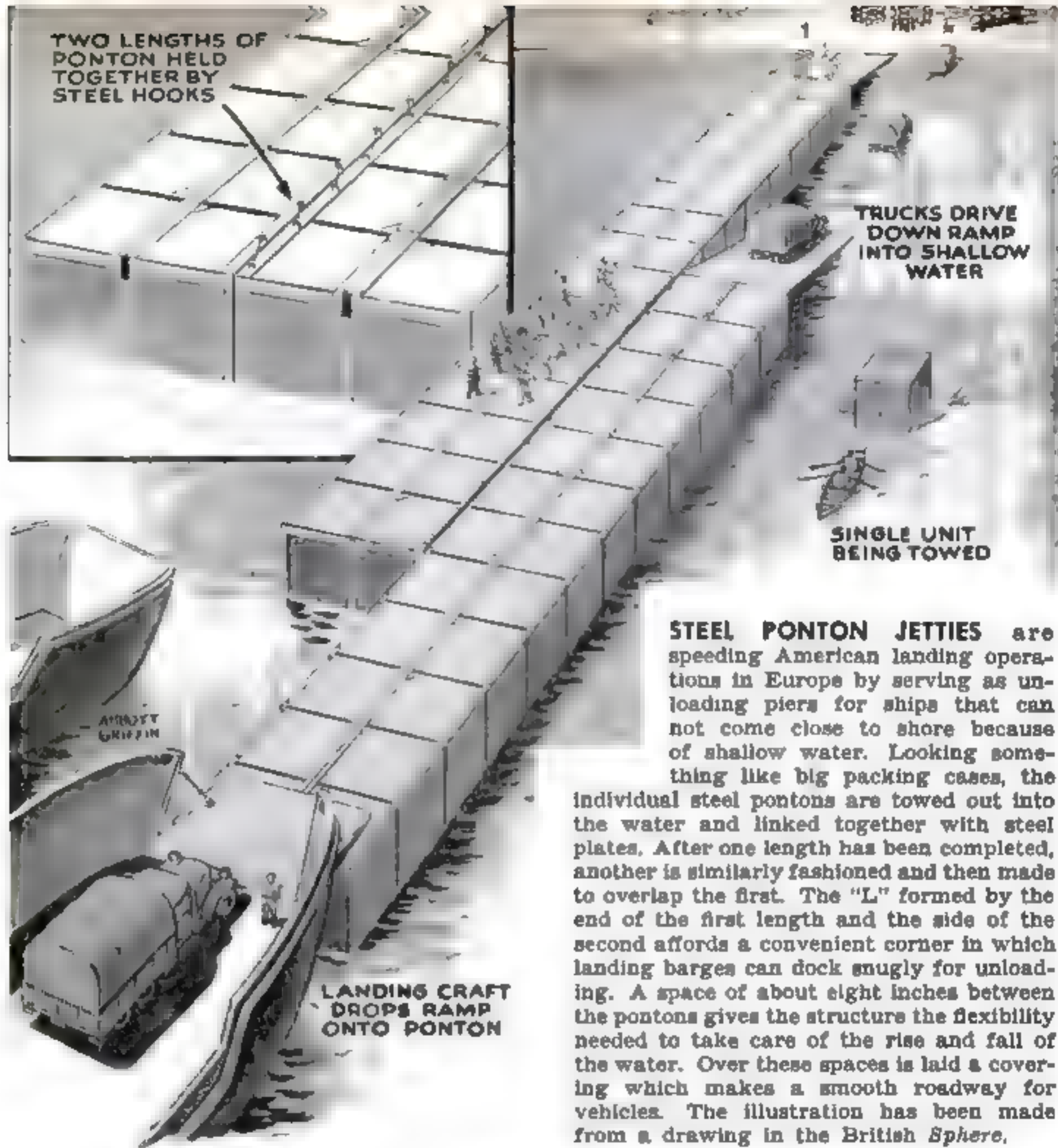
Two-way radio or receiver only, self-starter, trim tabs, parking brakes, steerable nose wheel, dual controls, glove compartment, dome light, roof window, polaroid glass, windshield wiper, ventilation, heater, fire extinguisher for engine, de-icers, luggage compartment, sunshades, soundproofing, standard instruments plus new ones, mudguards, safety belts, emergency doors, dual instruments, rear-view mirror, adjustable seats, bulging windows for vertical vision, floor windows and wing windows for low-wing plane, landing lights, flares for emergency night landings, built-in tie-down equipment for country fields, door locks, crank-down windows in doors.

TAIL DESIGN

Single rudder, double rudder, fixed rudder, retracting tail wheel, combination rudder and elevator in "V" design.

OF YOUR ENTRY IF YOU USE THESE SERVICE AIDS

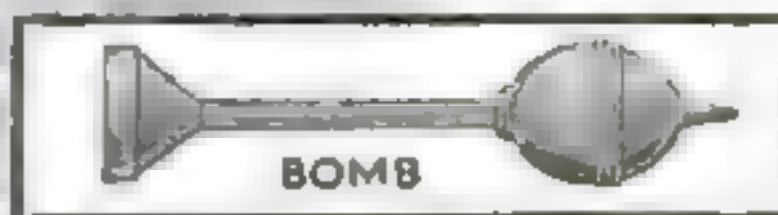




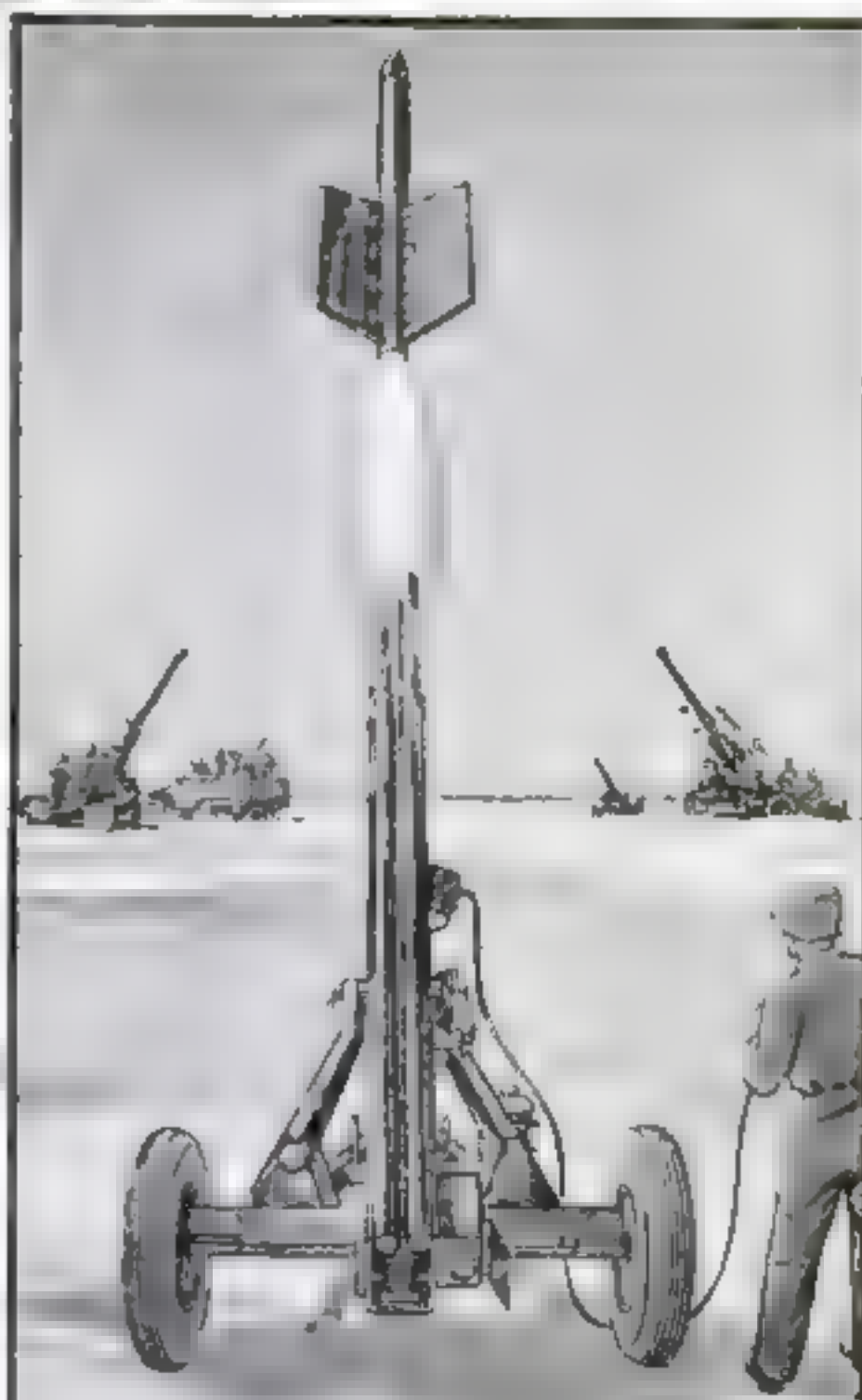
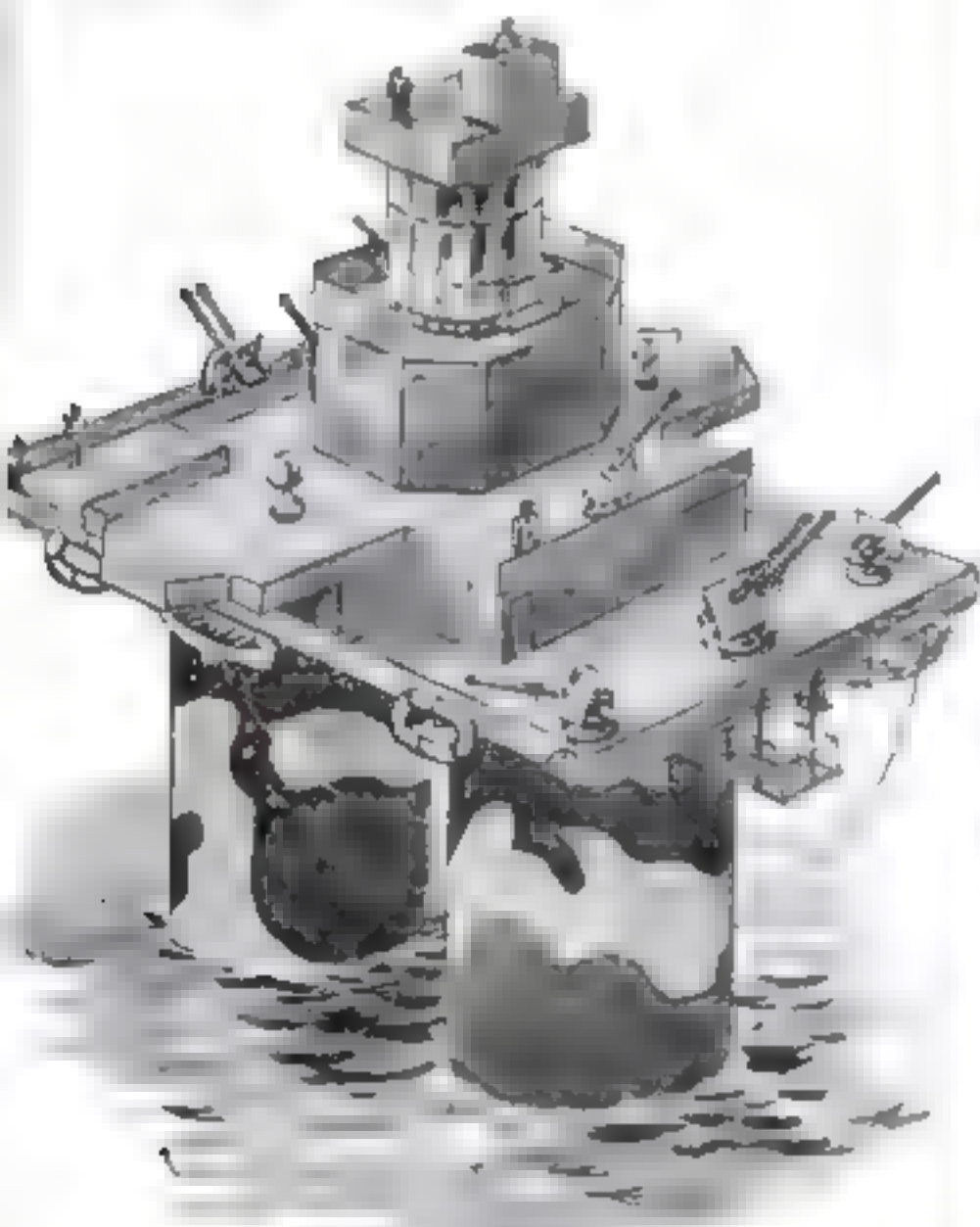
war ideas

Drawings by ABBOTT GRIFFIN

BRITAIN'S "BAZOOKA," known as the "Piat," fires a 2½-pound bomb that penetrates four-inch armor and can stop any German tank at 115 yards or knock out a concrete pillbox at 350. Weighing 33 pounds and carrying a spring to reduce recoil, the gun can be fired from the shoulder or with the butt grounded. It takes its name from the initials of its official designation, "projector, infantry, antitank."



STATIONARY "WARSHIPS" mounting batteries of ack-ack guns guard Britain's east-coast shipping against low-flying enemy planes. As shown in the artist's visualization, the forts, commissioned as "His Majesty's ships," consist of two 50-foot concrete towers with a superstructure.



"CLAY-PIGEON" shooting has been taken up by Allied ack-ack gunners who practice their marksmanship by blasting out of the sky the rockets that this electrically fired projector tosses high into the air.

Laying Tracks in the Sky

Across arctic wastes and desert sands, AACCS radio ranges guide our planes and guard their safety on the errands of global war.

By VOLTA TORREY

MODERN airways such as we have in the United States now run around the world. This means that the globe has been laced with new means of communication, for an airway without many different kinds of fast, reliable communication facilities is like a railroad right-of-way without tracks, signals, or telegraph wires.

The Army Air Communications System (AACCS) provides the invisible rails known as radio ranges over which the United Nations' heavy air traffic now races. The AACCS prevents confusion, congestion, collisions, and crack-ups by directing movements in and out of terminals. It provides the signals that warn flyers against storms and mountains. Its stations designate detours, and find and help lost airmen.

The AACCS is one of this war's biggest developments. It operates circuits 24 times as long as the equator, and transmits more words every 10 hours than there are in the Bible. Even though no two points on the earth's surface are more than 60 hours apart by air, a nonstop flight at 200 miles

an hour over all of the radio ranges of the AACCS now would take nearly three months.

Yet this system, serving both our own and our allies' airmen, is one of the shyest and least known of our war babies. When a high official of the Government flew to Moscow, he was so impressed by the ease of communication en route that he wrote a eulogistic letter, but addressed it to another Army agency rather than to the AACCS. Even generals in Washington have been caught assuming that AACCS signified some sort of antiaircraft activity rather than the Army Air Communications System.

The AACCS, furthermore, is so big and so new that no two eyes have seen it all, or can see it all for several years. If you were to make an inspection trip, you would find an AACCS station in a city which until recently no white man had ever dared enter, another alongside a sultan's swimming pool, another where fences are needed to keep out the curious kangaroos, and another in the crater of a volcano.

Antennas have sprung up all over the world as fast as dandelions. The AACCS was started only five years ago by three officers and six enlisted men; now it has a personnel of nearly 20,000, and needs more because it is still growing.

This young giant's headquarters are in the city hall of Asheville, a Smoky Mountain resort town in Buncombe County, North Carolina. The AACCS was moved there a



Somewhere in Hawaii is this temporary control tower, one of the many thousands operated by the AACCS. Between ports, pilots fly radio beams sent by range stations, which may be found almost anywhere—alongside a sultan's swimming pool, in a city once forbidden to white men, in a field fenced to keep out the kangaroos, or in the crater of a volcano

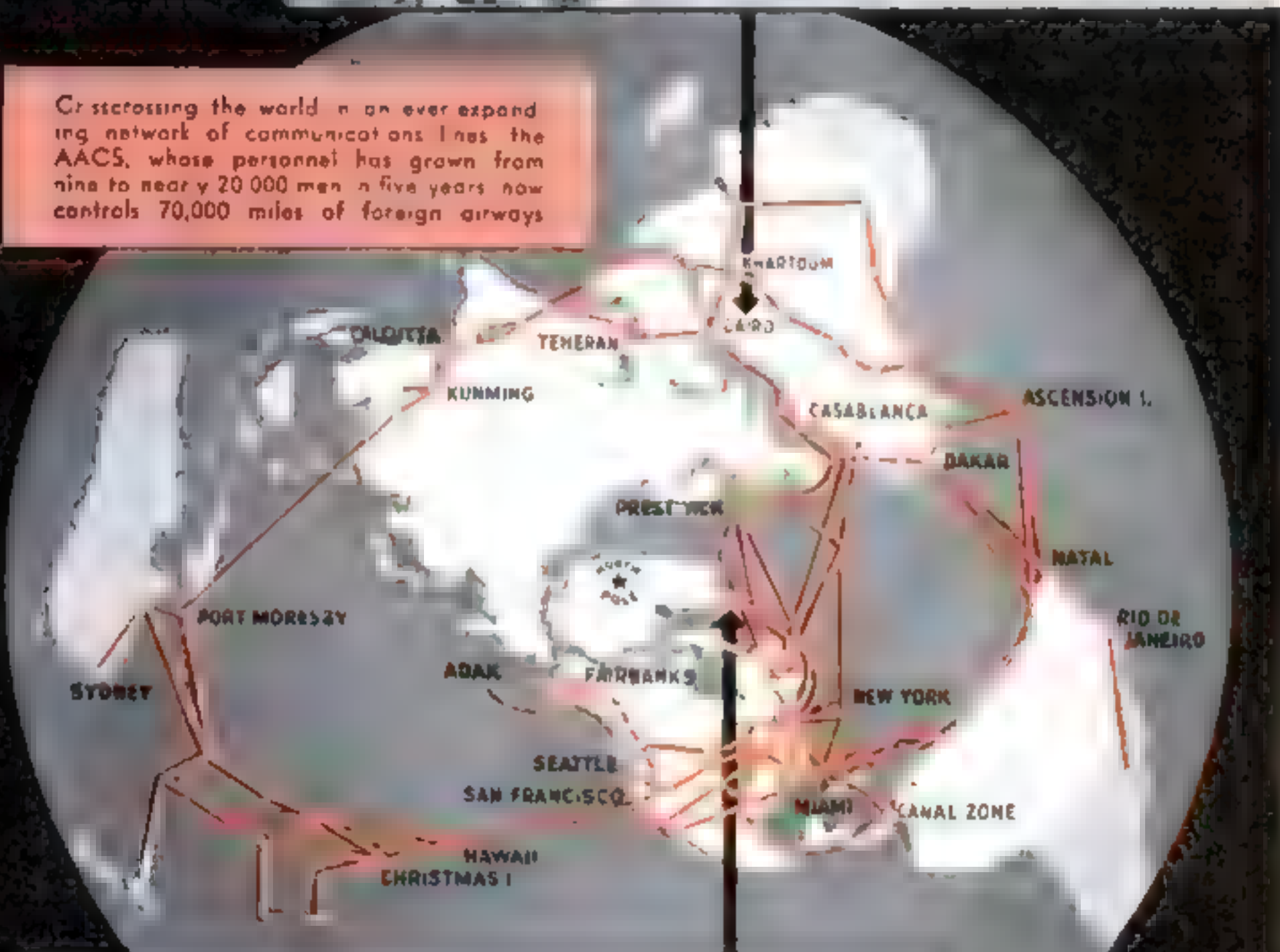
Symbol of America's huge air-traffic system, whose radio and telegraph lines reach from its headquarters in North Carolina to out-of-the-way nooks and crannies of the world that haven't even been explored, is the emblem seen below. Notice the initials AACCS spelled out in Morse code



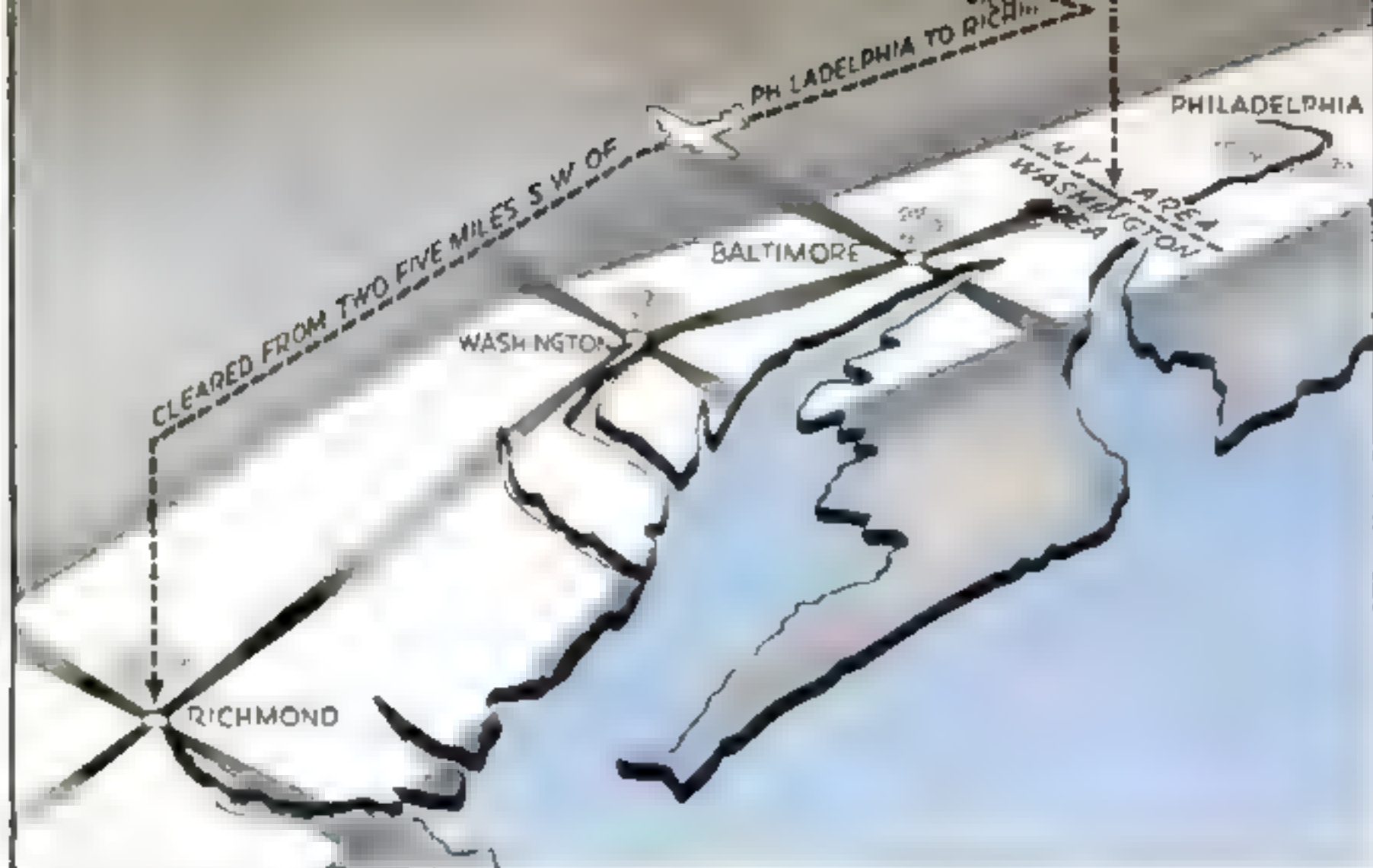
American Douglas cargo plane wings past the Pyramids on one of the airways which form a part of the globe-girdling AACCS network shown on the map below. Some of the links are telegraph lines, but most are invisible radio connections. Code is employed in nearly all messages transmitted.



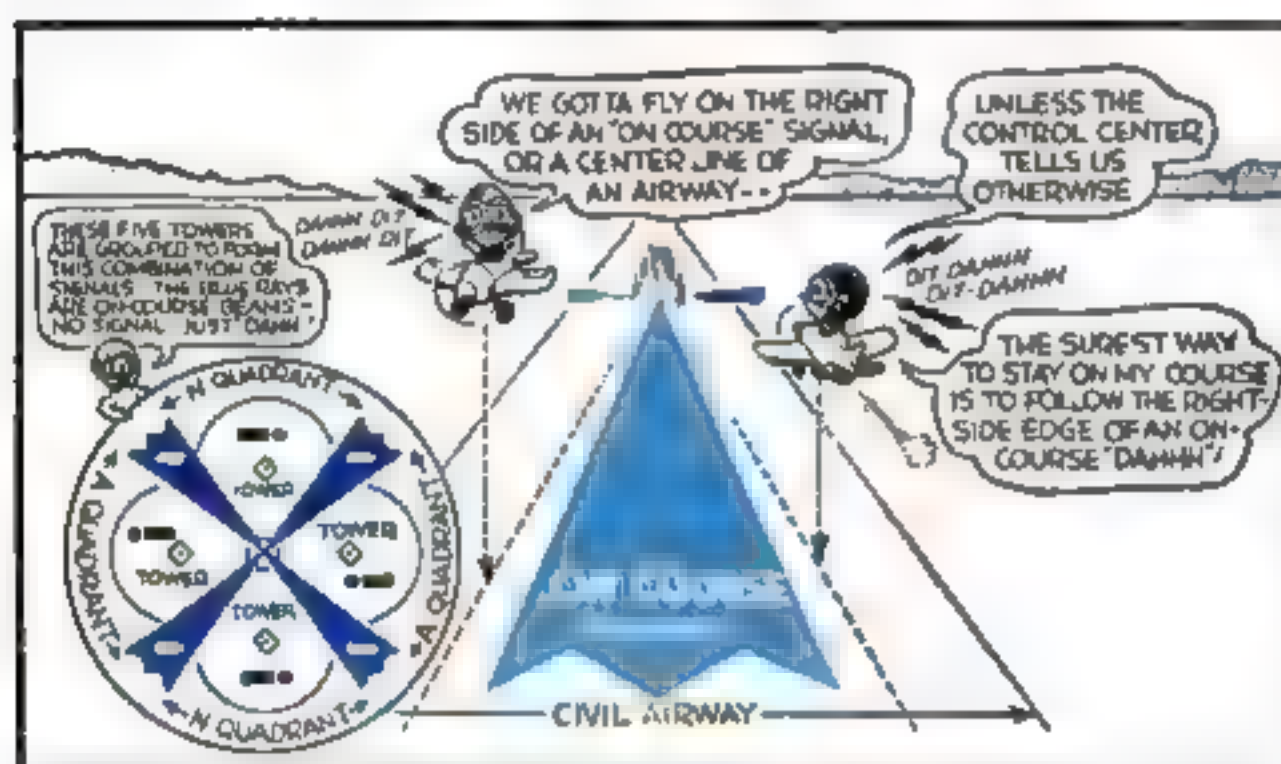
Crossing the world in an ever expanding network of communications lines the AACCS, whose personnel has grown from nine to nearly 20,000 men in five years now controls 70,000 miles of foreign airways.



This loop range station located in Greenland's icy waste broadcasts radio calls that guide our planes across the North Atlantic toward England. Service must be maintained continuously in spite of temperatures as low as 50 below zero and winds as high as 137 m.p.h.



HOW AACS POINTS THE WAY FOR EVERY ARMY PLANE



Drawings from USAAP Office of Flying Safety

A plane flying, say, from New York to Florida will be instructed as to course and cruising altitude by the New York area control and will be cleared as far as Richmond after Philadelphia has had approval from the center controlling the Washington area. Beams from the intervening stations will then guide the ship to Richmond, where it will have to be cleared for points farther south. The drawing at the left illustrates how pilots ride the range-station radio beams of the U. S. civil airways

year ago because of the congestion in Washington. The office where the mayor formerly guided local affairs is used now by wiry, tireless, little Col. Ivan L. Farman, a commanding officer whose barks are heeded around the world. He is surrounded by administrators and specialists in radioteletyping, blind landings, direction finding, and a score of other sciences.

These men run an organization that extends into the very thick of the fighting and to points as far away from the war as it is humanly possible to get. AACS men are among the first to land on nearly every shore taken by our troops, because communication services are the pillars that support our air power. For the same reason, other AACS men sit month in and month

out, faithfully transmitting messages in secret codes, at places where no one but a weatherman would ever think of pausing.

The Army Airways Communications System was built by "hams" as well as by Army and commercial airlines radio men. Many of the pioneers got acquainted before the war while tickling keys for fun. One new man arriving in India was greeted by the regional commander as "9DPS." These men were the only ones available with the know-how and the nerve to corset the earth with radio circuits as fast as they were needed.

The big radio concerns could not even manufacture the necessary equipment fast enough. So the Army also had to find and buy equipment from hams.

The first big job was the establishment before Pearl Harbor of an airway across the North Atlantic. This was done so quickly and so well that 98.5 percent of the planes leaving Newfoundland over that route have reached England, no transports have been lost, and the crews of most combat ships have been saved.

But there were many dark moments. Equipment for one station in Labrador, far away from civilization, was flown direct from the factory with a note saying that the screws needed to put it together could be obtained at the nearest hardware store. Colonel Farman had to fly those screws to the men. Another Northern station relied on a Canadian plant for power—until the plant burned down. Then the AACs men yanked the motor out of a snowplow and generated their own power.

After Pearl Harbor, stations were demanded at points inaccessible even by plane and jeep. The finest electrical equipment ever made sometimes had to be delivered by oxcarts, mules, elephants, and parachutes. Even the bricks for one station in India were toted there on the heads of a native contractor's bare-bosomed wives.

Merely getting the stuff out of the United States was agonizing work. Antenna poles failed to reach a bleak island because they looked like piling, and it was thought none was needed in that island's harbor. Snowshoes addressed to the Arctic were delivered to the British West Indies. A vital bit of



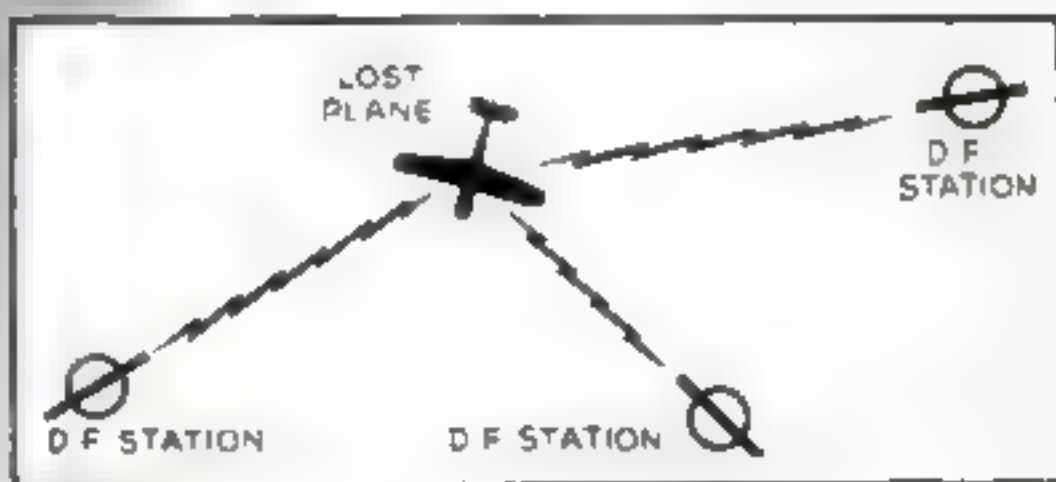
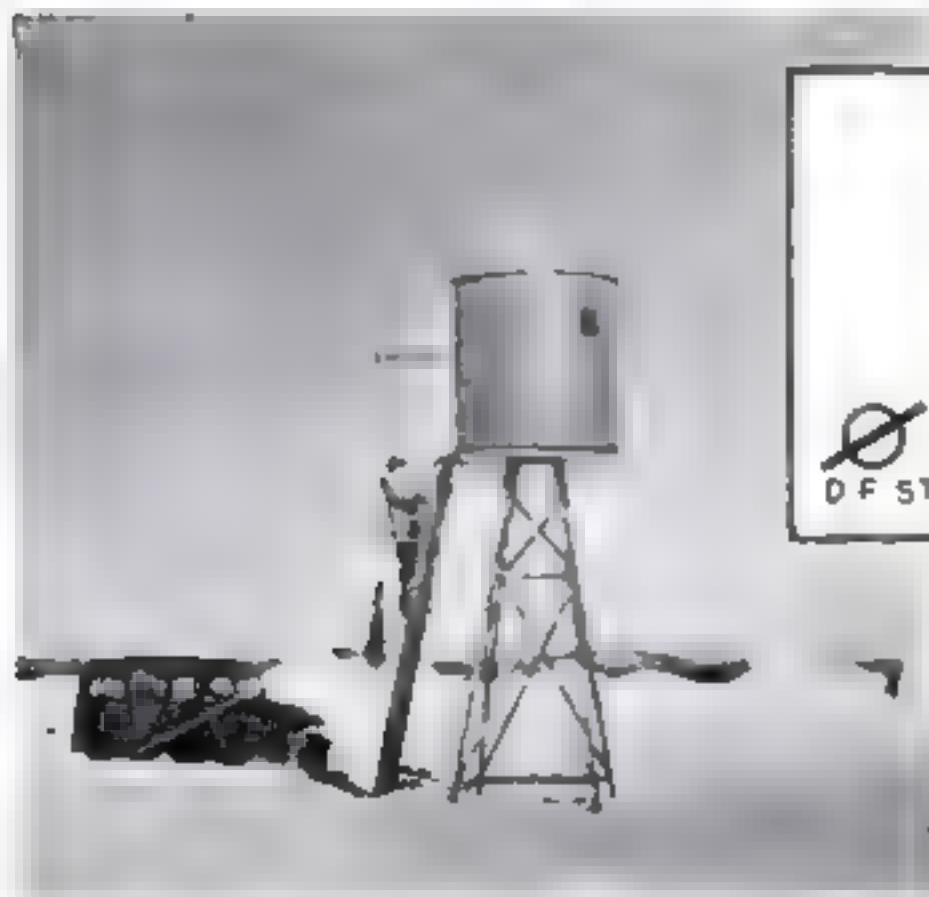
CONTROL TOWER. Although station beams act as signposts for planes, it is the men in the tower that give incoming and outgoing planes the red or green light. In times of trouble, these men may be called on to do a lot more. On one occasion, a temporarily blinded flyer was saved from possible death by tower men who "talked" him to the ground.

radio apparatus, missing for weeks, was found in a package labeled "Forms 14-A," which meant telegraph blanks. And when impatient men at one outpost ripped open a crate supposed to contain a receiving set they found a pinball game.

Today, however, everything needed for an adequate transmitting station can be flown from the United States and installed anywhere in the world in less than a week.

There are a lot of tricks that can be played with ranges. The Germans shot two beams over England during the blitz. Their bombers then flew in and dumped their eggs where the radio beams crossed. The British got wise, shot a third beam into the sky. For two nights *(Continued on page 198)*

DF'S LOCATE PLANES THAT ARE LOST OR GROUNDED



AACS's DF (direction-finding) stations, spotted all over the world, locate lost or grounded planes. Signals from the plane are picked up by two or more of the stations, each of which determines the direction from which the signal is coming. By triangulation, the plane's position is plotted, and either help is sent, or directions are given on how to come back on course. Left, a DF tower in the Arctic.

Earth Puzzle

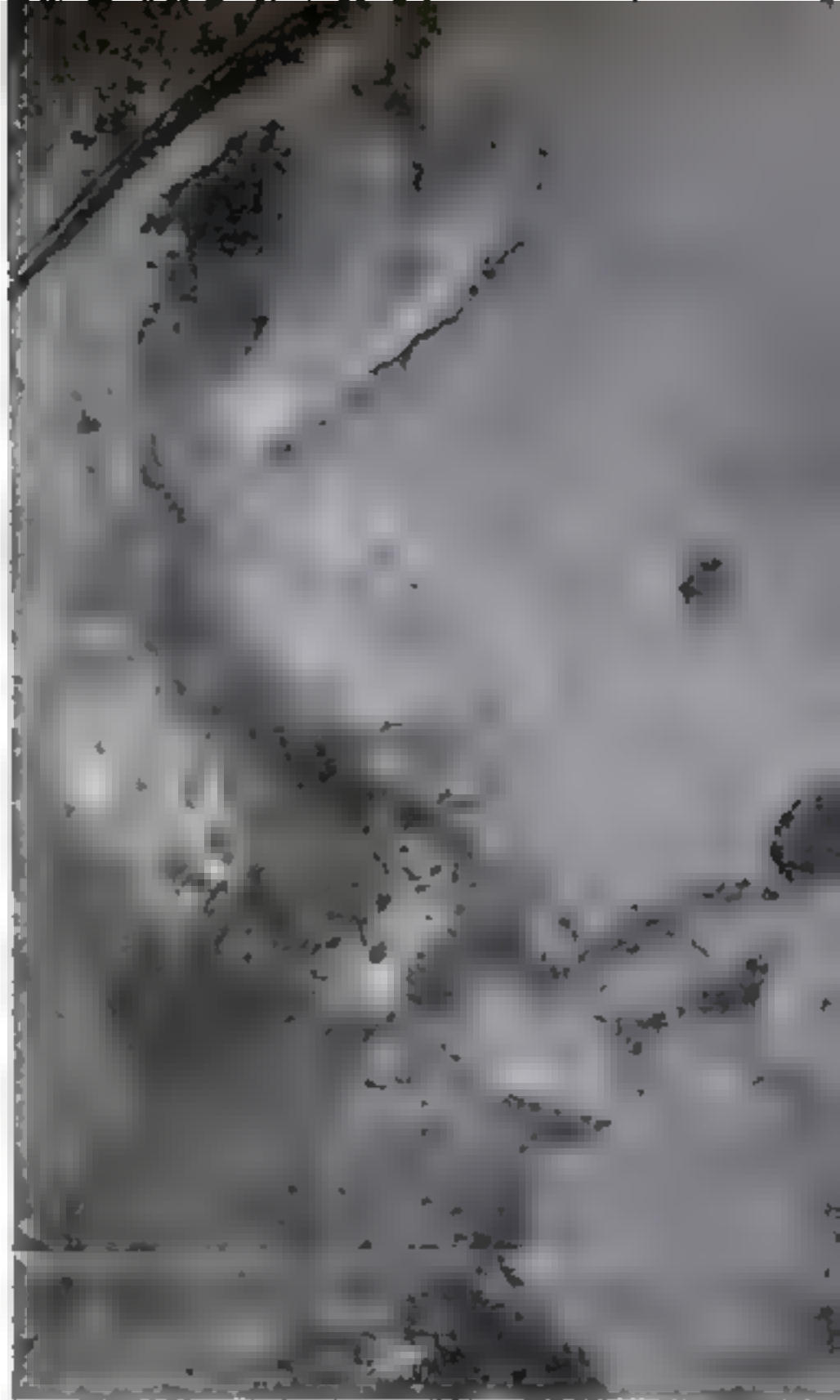
Aerial photos show giant cracks forming jigsaw patterns. . . . Not noticeable on the ground, they have the geologists guessing.

*Photo Courtesy Dr. Walter B. Lang,
U. S. Geological Survey*

THE mystery of the Animas playa is baffling the geological sleuths.

Playas are common landscape features in the southwestern part of the United States. They are stretches of level ground on which water accumulates during heavy rains and which later dry out into sheets of sun-baked mud. While examining aerial photographs of the Animas Valley in southwestern New Mexico, Dr. Walter B. Lang, of the U. S. Geological Survey, became interested in the puzzling, many-angled patterns showing on the surface of a dry playa. They were like the drying cracks that appear in the mud of a drained pond, but hundreds of times larger. Passing that way some time later, he was at first unable to find the markings, but careful examination revealed them as shallow depressions, cracks about three feet wide but only an inch deep, that formed polygonal figures averaging 90 feet in diameter.

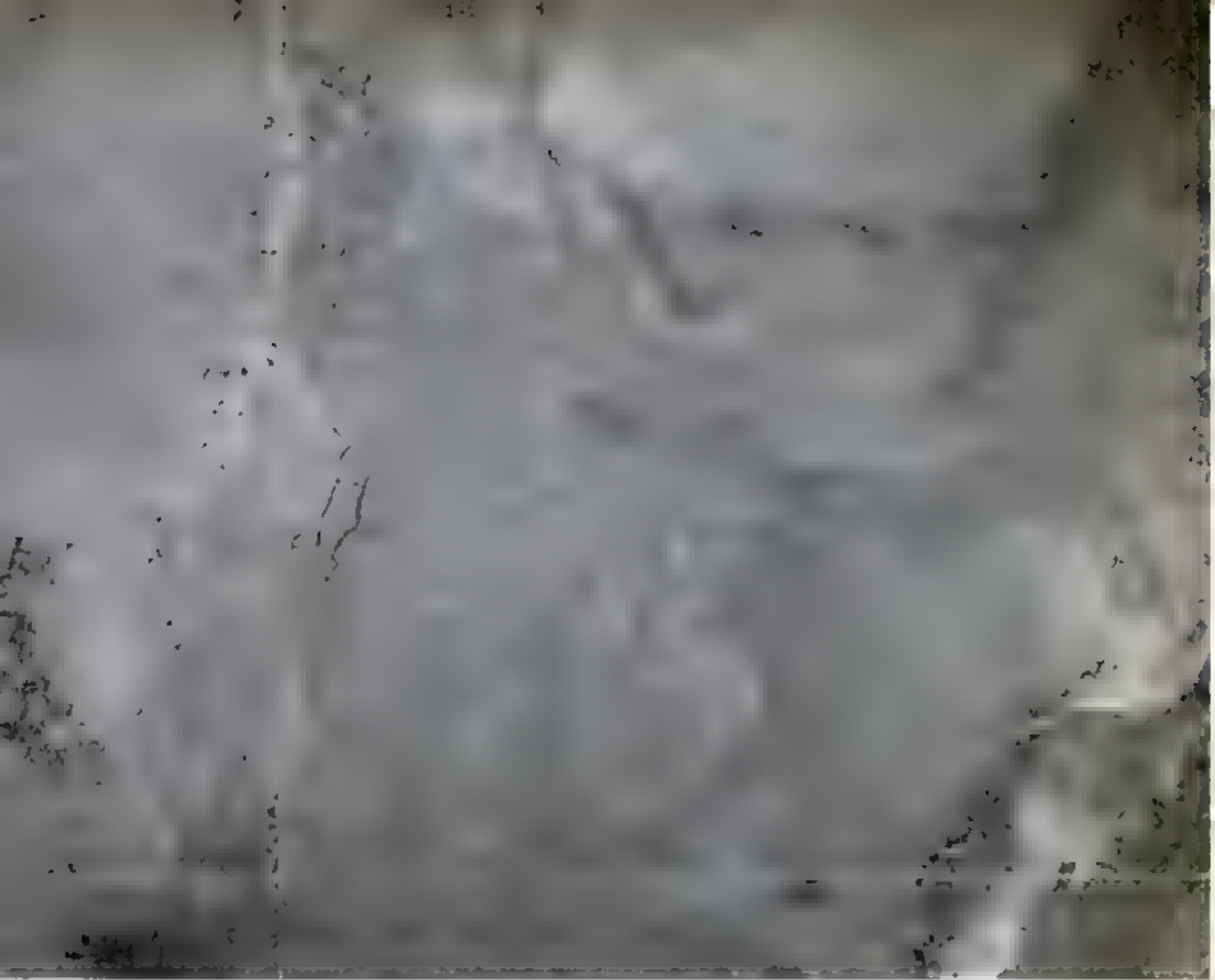
Although almost undiscernible from



ground level, because they are covered by a dense growth of foot-high bushy plants, they show up clearly in aerial photographs. Residents of the Animas Valley remember numerous "dry spells" during which the



HEMP-HARVESTING machinery is keeping pace with greatly increased production in the United States to meet the war-boostered rope requirements of the Navy and merchant marine. With the new International Harvester gatherer-binder, the mowed hemp, after from two to six weeks' "retting," is picked up by a series of round fingers and flat teeth mounted on eccentrics. It then passes to a deck where it is bound into bundles which are thrown to the ground out of the way of the machine on its next round. War Hemp Industries, Government-owned corporation, has built 42 mills for processing.

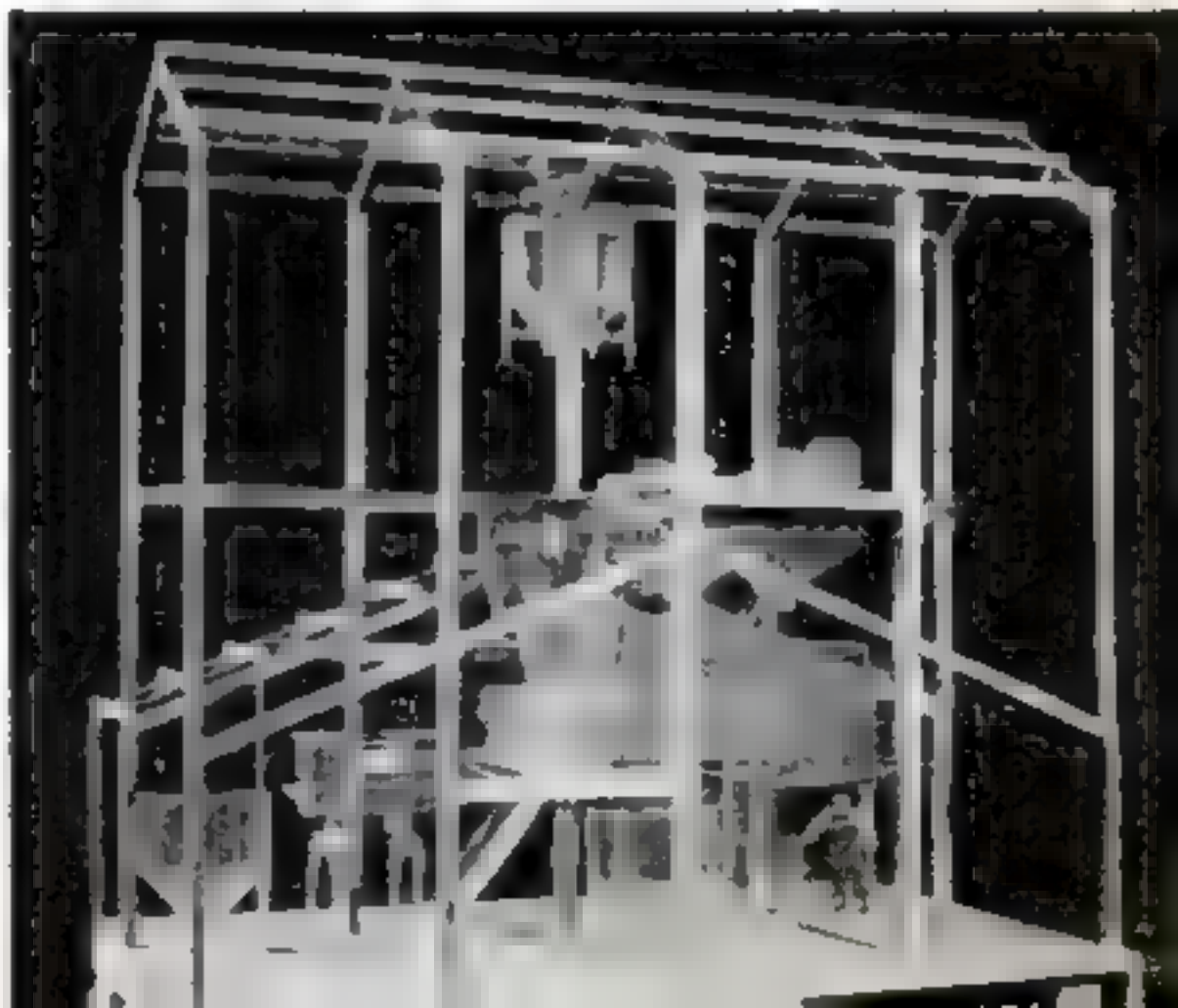


hardened mud of the playas was fractured by narrow, deep-drying cracks, which later were filled by surface material washed or blown into them. Dr. Lang thinks that the gigantic patterns are very old—the result

of many years of cracking and filling. Why the cracks always appeared at exactly the same places on the surface is a puzzle that Dr. Lang is working out. The Army Air Force has photographed this phenomenon.

TRANSPARENT PLASTICS are being used for scale models of installations by the Dewey and Almy Chemical Company, Cambridge, Mass., and it is claimed that savings effected absorb the cost of the model, which also offers many other benefits. Use of models reduces drafting time on structure, eliminates piping drawings, saves pipefitters' time, and conserves materials because of fewer changes on the job. In the model shown, scale one inch to the foot, wood construction is represented by wood, and steel equipment by plastic that affords easy visualization of the piping plan.

JUNE, 1944





A DIVING RECORD was recently established for fresh water by Colin O'Donnel at the big Grand Coulee Dam in northeastern Washington. The object of the diving was to examine the underwater apron of the dam on which water spills from a height of 374 feet at the rate of 900 tons per second. O'Donnel descended 273 feet below the surface, thereby setting a mark for other fresh-water divers to shoot at. It was not his lowest descent for salt water, however, for he exceeded it by just two feet several years ago when he worked at the record depth of 275 feet in the attempt to rescue the crew of the U. S. submarine F-4, which sank off Honolulu, Hawaii. The water pressure at this depth is about 120 pounds per square inch, or eight times normal air pressure at sea level.

As 900 tons of water per second pour over Grand Coulee Dam from a height of 374 feet, Colin O'Donnel, master diver, prepares to break the fresh-water record for depth. In salt water he dived 275 feet



CONDUCTIVITY is slightly less, but war-essential copper is saved and there is additional tensile strength in the new steel wire produced by the American Steel and Wire Company, Cleveland, Ohio. Controlled manufacture results in improved fatigue resistance, and a coat of zinc resists rust. Photos show workability.



The diver submerges for his examination of the underwater apron of the dam, 273 feet below the surface. Colin O'Donnel is shown going down the ladder from the deck of the diving raft. Complete inspection was held up by fire on the raft

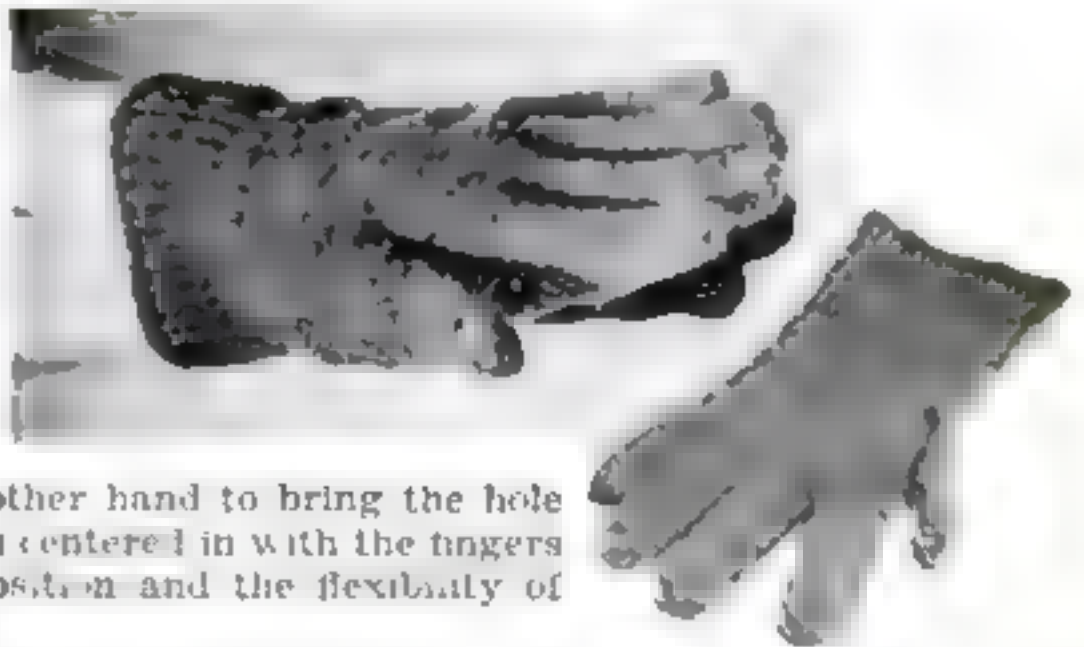
To Make Life Easier for the Soldier

MADE OF PLASTIC, the fireman's helmet below has been adopted by the Quartermaster Corps of the U. S. Army for use by fire details in place of one formerly made of hard rubber. This one is of laminated phenolic resin and canvas in three plies molded together in one operation with the exception of the shield, which is riveted on. It is light and strong and, of course, fire and water resisting.



DURABLE SPECTACLES for Army use have been designed by the American Optical Company, Southbridge, Mass., at the request of the Surgeon General's office. They have a tough metal frame capable of "taking it" under most conditions. In two years the company has filled 1,634,020 prescriptions.

AMBIDEXTROUS GLOVES that fit either hand equally well have been produced by the Army Quartermaster Corps with resultant economies. The new glove reduces the amount of stock that must be carried, because when a soldier loses or wears out a glove, he needs only one replacement. Time is saved in putting on the gloves, and if one has a hole in the palm, it can be shifted to the other hand to bring the hole on top. In the knitting, the thumb is centered in with the fingers so that the thumb, owing to its position and the flexibility of the material, can turn either way.



WARM AS SEALSKIN, this new Army mukluk has additional advantages over other types of footgear for arctic regions. Made of strong white duck fabric, with a leather bottom, it is worn over woolen socks. The entire boot is



porous to allow perspiration to evaporate, thereby avoiding freezing, and the construction provides room for the wearer to wiggle his toes. The adjustment is made with the aid of canvas straps, as illustrated at the extreme left. In the accompanying picture the mukluk is shown (top) folded, and (left to right) the khaki cushion-sole sock, the arctic sock worn over it, and the 12-ply porous burlap insole.



AUTOMATIC CONTROL of airplane engines is advanced by the new model of the Simmonds-Hobson automatic engine control, known as the Mark 46, now being installed in United Nations planes. This control is designed as an adjunct to supercharged aircraft engines. It automatically selects mixture strength as well as manifold pressure, and provides selected settings of the throttle control lever at "Take-Off," "Rated," and "Economic Cruising Boost" positions. Heart of the device is an aneroid which responds to changes in manifold pressure and actuates carburetor throttle control.

NAVY VERSION of the B-24 Consolidated Liberator, the PB4Y patrol bomber, has a single tail instead of the twin rudder so familiar on the Army job. Two-gun side blisters replace the openings for waist gunners, and there are two double .50 caliber turrets on top in place of the single one on the new Army Liberator. Nose and tail turrets are new.



PRIDE OF THE NAZIS is this six-motored ME-323 transport (P.S.M., July '43, p. 94), which they call the largest land plane in the world although its 181-foot wing span and 93-foot length are dwarfed by our Douglas B-19 bomber. It has 10 landing wheels, five on a side. Allied fighters shot down 37 of the clumsy craft at a clip in Tunisia.

Oil drums about to be put into the cargo hold of a Nazi ME-323 transport. Sometimes called a "power guder," the ship can hold 130 fully armed soldiers.

Here a heavy gun is being rolled into the open nose. Mann'd by two pilots, two engineers, and a radio operator, the clumsy craft struggles along—a target for enemy fighter planes.

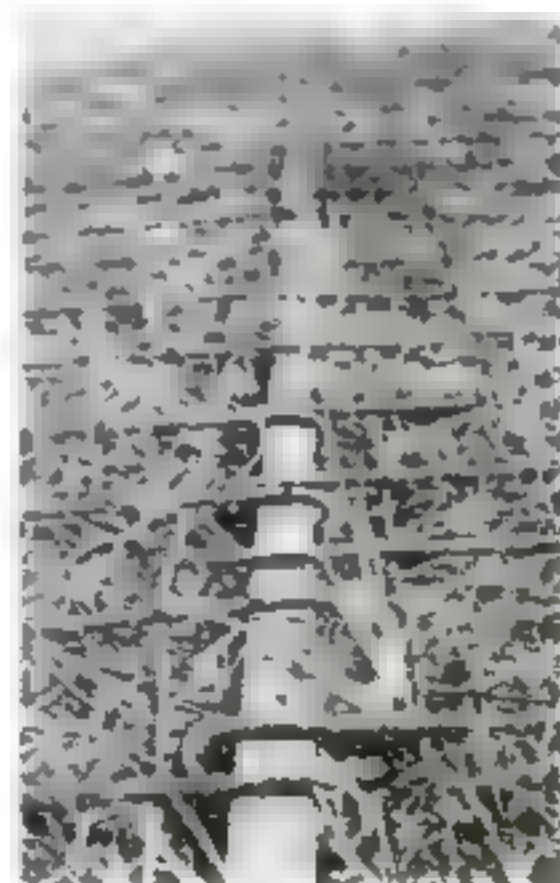




ARMY AUTOGIRO. Pilots of the AAF are now taking the measure of this windmill plane, one of a service-test lot recently delivered by the Kellett Aircraft Corporation, Philadelphia. Designed for liaison and observation work, it is powered by a 300-hp. Jacobs engine and is said to have higher speed, better take-off qualities, and more

maneuverability than earlier members of the 15-year-old Kellett line. The bubble-type transparent canopy gives almost perfect visibility, with overhanging panels that allow the pilot and observer to look straight down without banking the ship. Army designation of the craft is YO-60.

ROLLABLE RUNWAYS speed the laying of temporary landing strips for light planes where time or materials do not permit the use of steel panels. Wire mesh reinforced with steel bars is unrolled and the sections are laced together by running strips through hooks at the edges, as shown at the right.





Prof. Felix Ehrenhaft displays a tube of gases produced, he says, by decomposing water with a magnet

Magic with MAGNETISM

If this experimenter is right, his discovery will upset all our accepted ideas on this familiar force.

By ALDEN P. ARMAGNAC

CAN a magnet take water to pieces? No, say physics textbooks. Yes, says Prof. Felix Ehrenhaft, former director of the Physical Institute at the University of Vienna, who now carries on his research in New York. If he should turn out to be right, his findings in the realm of magnetism promise practical applications as far-reaching as the dynamos, motors, transformers, telephones, and radio that have stemmed from Faraday's fundamental research in electricity.

For his "impossible" experiment, Dr. Ehrenhaft employs the simplest of apparatus. Two shiny rods of pure Swedish iron, sealed in holes through opposite sides of a U-shaped tube, resemble a setup familiar to high-school students for breaking up water into hydrogen and oxygen gases by passing electricity through it. And that is exactly what would happen if Dr. Ehrenhaft

attached electric wires from a battery to the rods. But he does no such thing.

Instead, he uses the iron rods as pole pieces, or "north" and "south" ends, of a magnet—either an electromagnet or a permanent magnet. Bubbles of gas rise through the twin columns of acidulated water, to be collected and analyzed. As might be expected, nearly all of the gas is hydrogen, liberated by a commonplace chemical interaction between the iron rods and the dilute sulphuric acid, one percent by volume, in the water. But the phenomenal part of the experiment is that oxygen also turns up, Dr. Ehrenhaft recently told the American Physical Society. To be specific, it is found in clearly measurable proportions ranging from two to 12 percent of the total volume of gases. When the gases obtained with a permanent magnet are separated, the larger proportion of oxygen is found above the north pole of the magnet. After rigorous precautions that seem to rule out all other explanations—including short-circuiting the magnet poles with wire, so that the poles will be at the same electric potential—Dr. Ehrenhaft concludes that there is only one place the oxygen can possibly come from. And that is from water decomposed with a magnet! Without a magnet, pure hydrogen is evolved.

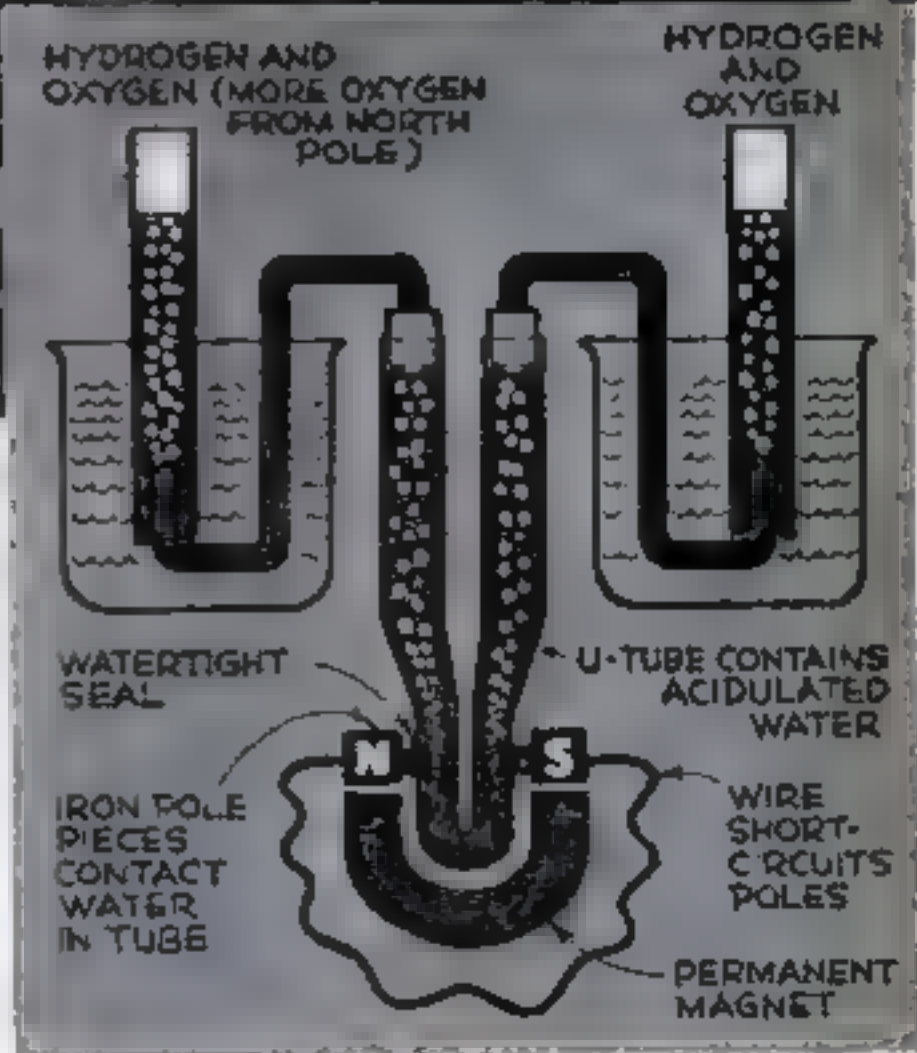
There is an interesting sidelight to this experiment. A strong permanent magnet of the Alnico type suffers a marked loss of strength—say, 10 percent in 24 hours—after being used to decompose water, Dr. Ehrenhaft observes. In fact, makers of the magnets, which are supposed to last for years without material change, have viewed what happens to them with astonishment and dismay. But no fault lies with their products. Energy from an electric battery is used up in decomposing water, and it would be only reasonable to expect energy stored up in a permanent magnet to be drained likewise.

What gives the utmost significance to the reported feat of breaking up water with a magnet is the fresh evidence it offers for the existence of "magnetic current," or a flow of magnetically charged particles, which has been suspected by noted pioneers and which Dr. Ehrenhaft now maintains he has proved. Confirmation of this amazing discovery would point to a possible future rival of electric current, perhaps capable of being harnessed in undreamed-of ways.

Needless to say, the scientific world will require a whole lot of convincing, since Dr. Ehrenhaft's conclusions flatly contradict long-established beliefs. As every school-boy is taught, a magnet has a north pole and a south pole. Break it in two with a hammer, and each piece will have a north



MAGNETIC DECOMPOSITION OF WATER?
Using this simple apparatus, Dr. Ehrenhaft reports, he performs the "impossible" experiment of taking water to pieces with a permanent magnet. This magnet, of horseshoe shape, is seen at the bottom of the tube. Bubbles of gas rise from the metal poles sealed in the tube and are led to water-filled beakers, where they are collected for analysis. Both hydrogen and oxygen are found to be present, most of the oxygen coming from above the north pole of the magnet. A length of wire short-circuits the ends of the magnet to rule out any difference of electrical potential. The drawing at the right shows the details of the setup for this startling test





Amateurs can test the strength of a magnet by measuring the distance it makes a strip of iron jump

pole and south pole of its own. No law forbids you to imagine a magnet with only one pole, and the idea comes in handy in certain electrical and radio calculations. But as for actual fact, you cannot have one pole without the other, an experimenter named Peter Peregrinus believed; he demonstrated it to his satisfaction, using a loadstone, in

the year 1269, and prevailing opinion has backed him up ever since. (As we know now, the loadstone that he floated on a platform in water simply turned until its north pole faced the south magnetic pole of the earth, and vice versa. It showed no observable excess of north or of south magnetism—and hence the conclusion that the two were always equal.)

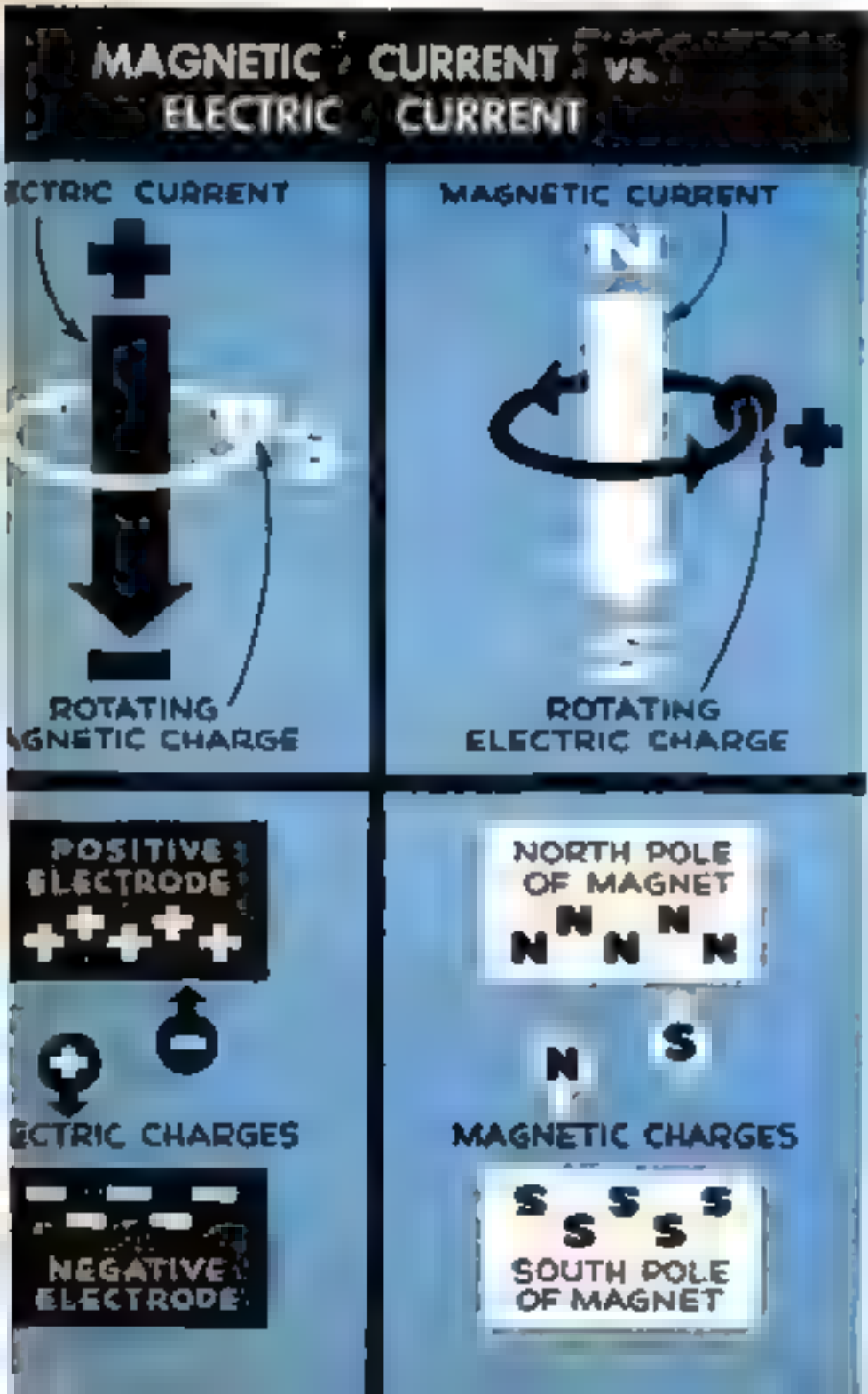
But would the dictum of "no separate magnetic poles" still hold true in a far more delicate test—say, if you substituted microscopic particles of iron or other magnetic metals, as tiny as particles of smoke, for the massive chunk of rock that Peregrinus used? Dr. Ehrenhaft has tried it. In an air gap between the north and south poles of a magnet, he sets up what he calls a homogenous magnetic field, that is, with the lines of magnetic force absolutely parallel. In this field, he finds, the metal particles move toward the north or south pole, reversing their direction according to the direction of the magnetic field. On the particles, he concludes, there must be an excess of north or south magnetic charge. Expanding the terminology of Faraday, he calls the particles magnetic ions. They are the single magnetic poles shown at the lower right of the colored drawing. Instead of bearing plus or minus electric charges, as familiar ions do, they carry north or south magnetic charges.

Now, just as traveling electric ions form an electric current, why shouldn't traveling magnetic ions form a magnetic current? See for yourself another of Dr. Ehrenhaft's startling experiments, and draw your own conclusions.

This time the heart of the apparatus will be a small glass cell, fitted as before with pole pieces of pure iron that dip into water containing one percent of sulphuric acid. An electromagnet, turned on or off at will, energizes the poles. From a projector, a powerful beam of light converges upon the narrow gap between the pole pieces, and a low-power microscope, mounted horizontally, reveals what happens there. Adding a camera provides a permanent record.

You begin with the magnet turned off. Looking into the eyepiece of the microscope, you see streams of bubbles rising from both pole pieces. They are of hydrogen gas, liberated by the same chemical action as in the first experiment.

Throw the switch that turns on the magnet, and the scene abruptly changes. Stopped dead in their tracks, some of the bubbles cling to the pole pieces. Others leave one pole and travel to the other. Dr. Ehrenhaft calls special attention to bubbles moving downward against their own buoyancy, impelled (Continued on page 222)





A glass cell, heart of the apparatus below, contains poles of an electromagnet, acidulated water

These photomicrographs made by Alvin P. Freeman, show what happens in the cell. 1. With the magnet off, hydrogen bubbles liberated by chemical, act on rise from the pole pieces. 2. When the magnet is turned on, the poles attract or exchange bubbles. (Note the large bubble defying buoyancy to move downward from upper pole.) 3, 4. A whirling of bubbles appears as a large white blur. Bubble tracks between the magnet poles suggest magnetic current. A conical upper pole aids in photography.



Through a low-power microscope, mounted horizontally Dr. Ehrenhaft observes the goings-on in the glass cell. What he sees, photographed above, convinces him that he is watching hitherto unknown forces at play. A powerful beam of light from a projector is focused on the narrow gap between the pole pieces of the electromagnet to make the odd bubble dance visible.



Does Your Car Look Its Best?

YOU CAN GET RID OF DENTS, SCRATCHES, AND SQUEAKS IN YOUR OWN GARAGE BY FOLLOWING A FEW SIMPLE STEPS

By Ralph Rogers

DAMAGED body and door panels and bent fenders can spoil the appearance of your car even when they are thought to be too small for a professional shop-repair job. Usually where there is a dent, the paint will be cracked and will soon begin to peel, making a spot that can be attacked by rust. All small repairs can be done in your own garage, and many more serious ones, including straightening and welding of actual breaks, are not too difficult for the driver-mechanic if he follows a few simple rules.

The driver who takes pride in the appearance of his car will also want to touch up thin spots in the finish even when the metal has not been damaged. And he will be wise to take a few elementary precautions to keep an original finish or a new paint job looking its best for a long time.

Before an attempt is made to straighten a panel or fender, the damaged place should be examined carefully to determine from what direction the damaging force came, at what point it first made contact, and where it continued its line of travel across or into

the metal. This is important, for if an expert repair is to be made, the metal must be pushed back in just the opposite sequence to that in which it was caved in. The place to start the repair is the place where the damage stopped.

High spots, where the metal buckled out after an impact pushed it in, are always hammered down first; then the low spots are hammered up. Never start by hammering the low spots because this will stretch the metal out of shape, causing additional work to bring it into line and making it necessary to repaint an entire panel.

Be sure also to clean the undersurface with a wire brush, putty knife, or scraper to keep hardened dirt from pitting and blistering the metal and from scarring the dolly and hammer. A thin coating of oil on the finished side will show up defects that might not otherwise be seen, will protect the finish during hammering, and on small jobs may even save repainting. If it is more comfortable to work with a wheel or bumper removed, do so, for plenty of room is needed to handle the tools properly. Torn metal

should be straightened first and then welded.

Drawings below show a system of unlocking and unrolling the damaged metal in an auto panel as suggested by the Fairmount Tool and Forging Co., of Cleveland. The panel was struck at *B* (Fig. 1) with force moving in the direction of the arrow. *B* was pushed in, and the flange at *C* and the point at *A* bulged out. *A* was the last to buckle and is the first point to be unlocked, a dinging spoon and hammer being used, as in Fig. 2. *C* is dinged down next; then the low metal is bumped up from below with a dolly block, starting at *B* and working to *E* (Fig. 3) and completing the job by working from *B* to *C*. The contour on finishing these simple steps will be exactly the same as before the accident, as shown in Fig. 4. Fenders are straightened similarly.

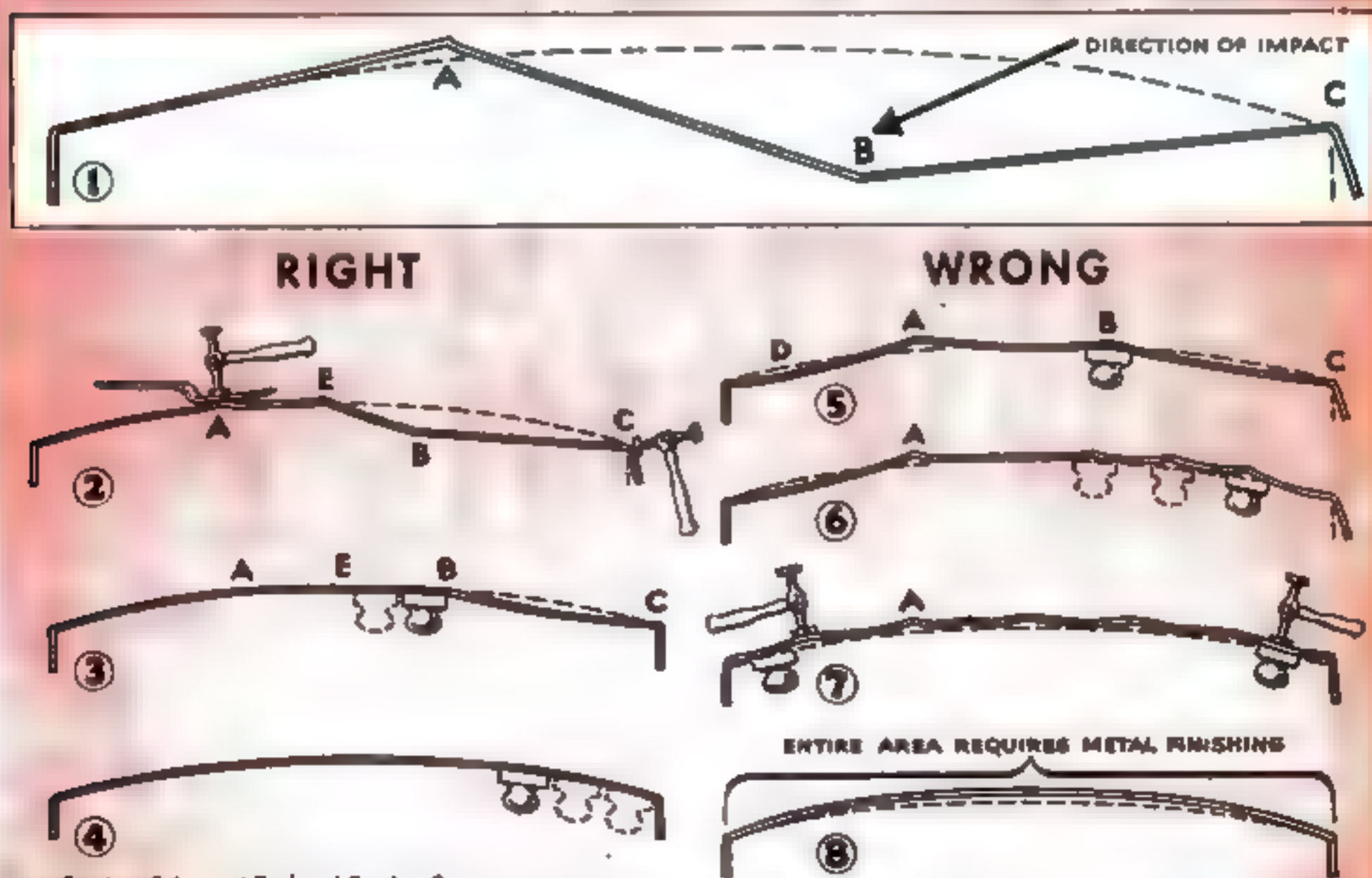
Figures 5 to 8 illustrate a wrong way to straighten the same panel. When *B*, the low point, is roughed out first (Fig. 5), *A* remains locked and acts as a fulcrum to depress *D*. Further roughing from the underside raises a series of humps (Fig. 6) that must be smoothed out with hammer and dolly (Fig. 7) and will leave the metal stretched beyond its original contour (Fig. 8).

Use the same finish as the original when touching up spots or painting a panel, for while enamel and lacquer may match perfectly in color, they react differently to weather and the patch will soon be noticeable. Dry enamel with a heating lamp, if possible, to approximate factory procedure; then allow a little time for seasoning before applying polish. Lacquer can be treated with liquid polish as soon as it dries. Wait about two weeks before using wax on either to let new and old finishes blend.

Original finishes and new paint jobs can be made to last longer if the car owner realizes that even the new synthetic lacquers, rustproofing undercoats, and better enamels of the last decade or so need some care. Few realize, for instance, that the ultraviolet rays of sunlight are destructive to the binder carrying lacquer or enamel pigment or that, if a car remains outdoors overnight, dew and fog assist the action of the ultraviolet rays when the morning sun gets in its work. Fortunately this deterioration takes place only on the surface, and a suitable polish will remove the dead film and restore the gloss.

Salt and calcium chloride, used sometimes to melt ice and snow, make solutions that

REPAIRING DENTS IN YOUR CAR is simplified by the process shown below. The buckle that occurred last is the key to a perfect job of straightening. The panel below was hit at *B*, which caved in. *C* buckled next, and then *A*. Dinging *A* down unlocks the damage so bumping can unroll the bent metal



Courtesy Fairmount Tool and Forging Co.

may splash on a car with harmful effects to lacquered and enameled finishes and to chromium plate. The air near the seacoast is salty and humid, and its damaging action is increased by high temperatures.

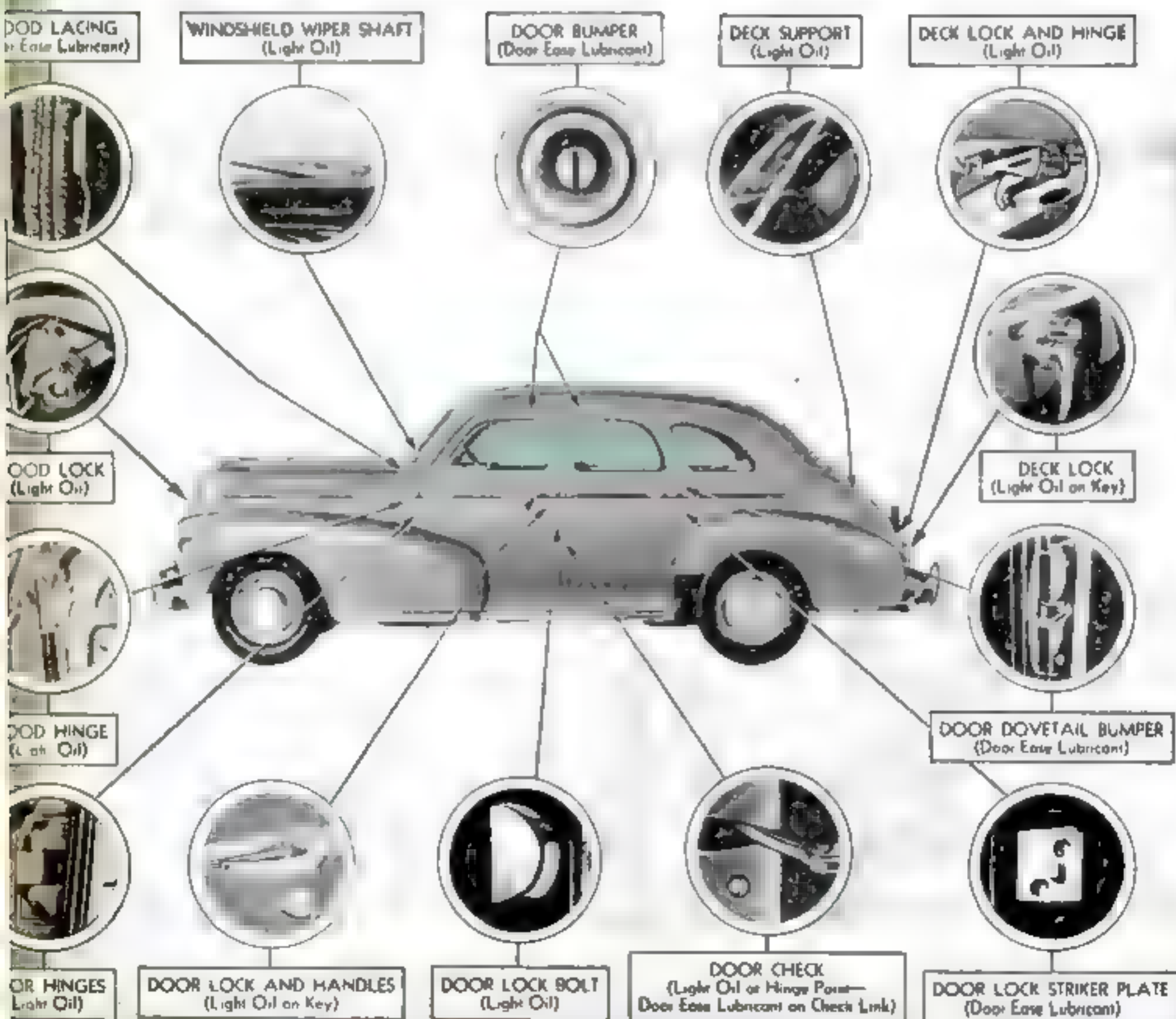
Even without these hazards, when a car becomes covered with a film of dust, it should be washed with plenty of clear, cold water and a sponge. Avoid rubbing until all grit has been removed. Any soap should be mild and should be thoroughly rinsed off because it can make difficult spots when it dries. Never wash a car in direct sunlight, and always allow the metal to cool if it has become heated. When washing won't suffice, liquid polish cleans well. A light abrasive paste cleaner, used sparingly to avoid wearing the finish thin, will help if the car has been neglected for a long time. Complete this job with liquid polish or wax. A good brand of tar remover is also useful. Hard-

ened tar may be softened first with lard, butter, kerosene, or gasoline containing no coloring matter or ethyl.

Chromium-plated parts require occasional wiping with light oil or kerosene. They can be protected with a coating of clear lacquer or wax. Scuffed or worn places should be cleaned with a mild kitchen scouring compound, such as is used on porcelain, or a standard chromium-plate cleaner, and then protected with wax, clear lacquer, or a thin film of oil. Repeat the process occasionally on spots worn through to the metal. Stainless steel can be cleaned effectively with a light abrasive polish.

Care of the auto body should always include judicious lubrication that will correct or prevent annoying squeaks. The chart below shows the parts that need attention and the kind of lubrication recommended by General Motors.

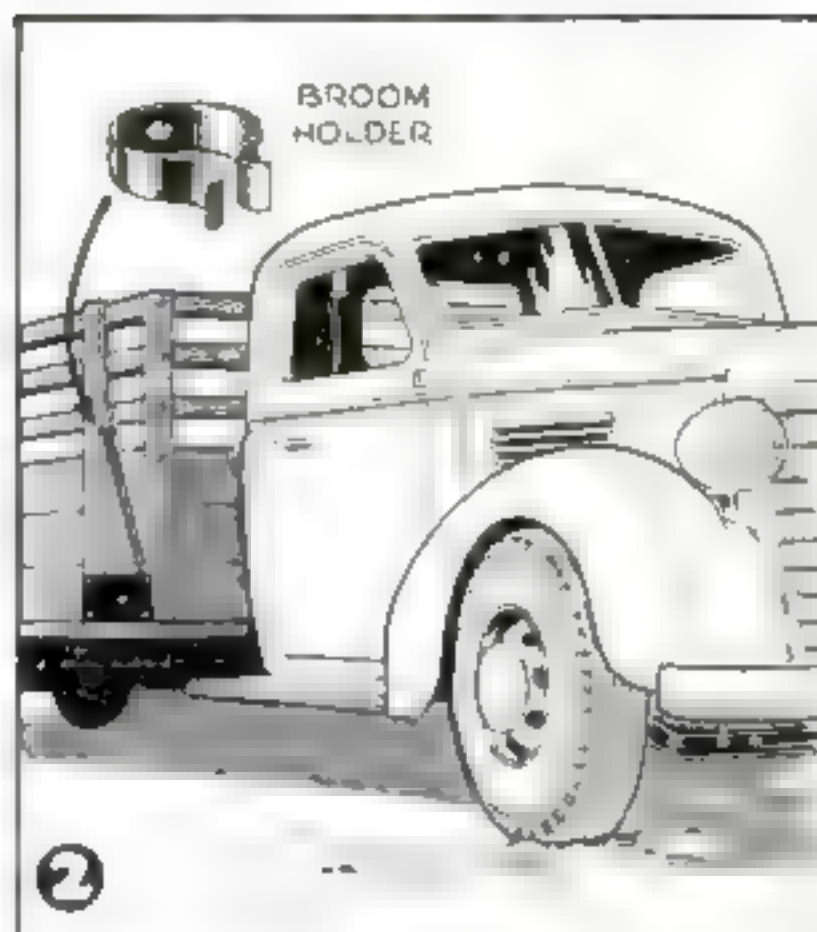
BODY LUBRICATION CHART



USEFUL AUTO HINTS



Drawings by
William Patrick

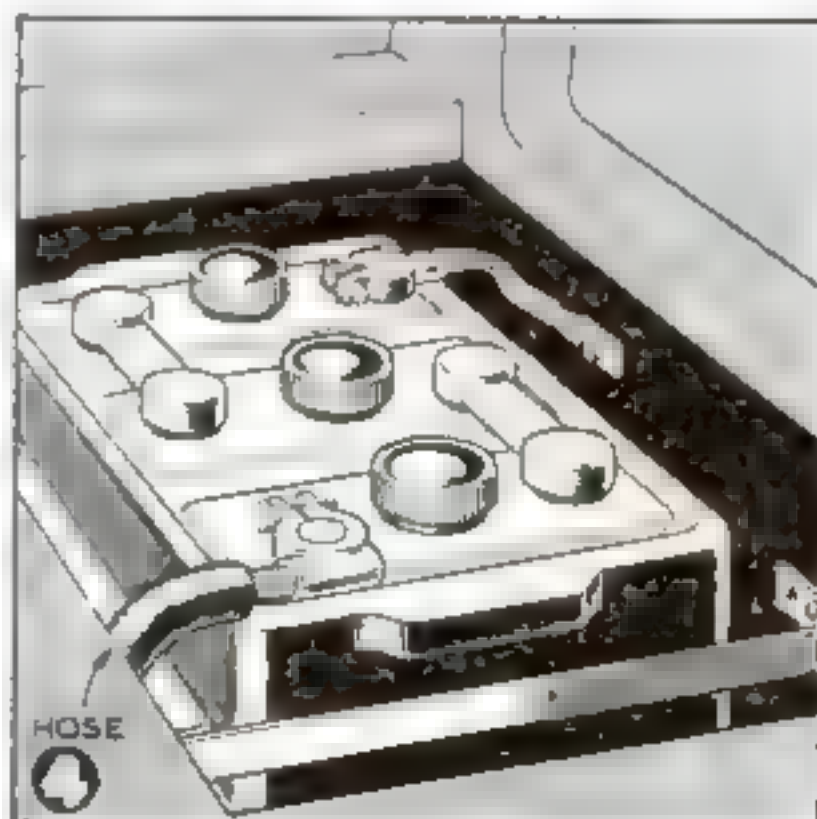
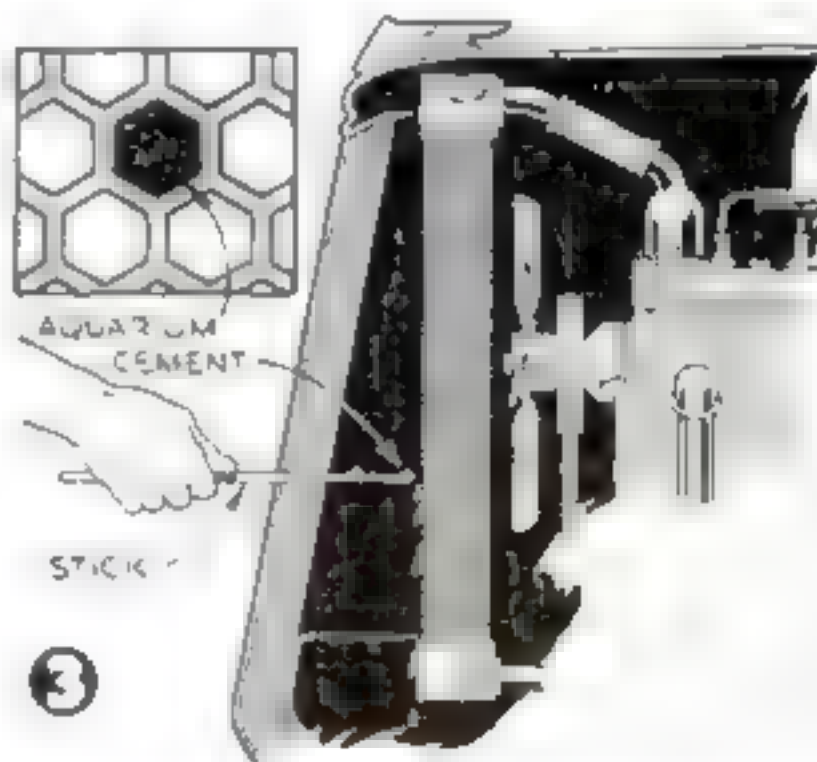


1 DENTS IN HUB CAPS can be removed easily by backing the damaged cap with sand and hammering lightly from the inside with a ball peen. Fill a bucket with sand piled in loosely, lay a cloth over it to guard against scratching the finish, put the cap on the cloth, as shown, and press and twist it a little to bed it down.—A. H. W.

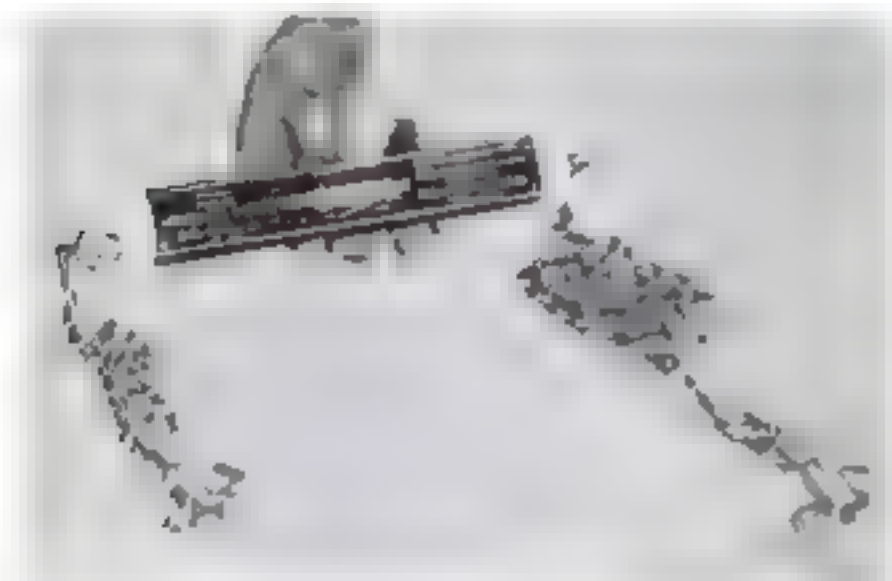
2 KEEPING A CROWBAR on the side of a truck, where it can be reached when needed and won't clatter on the floor and endanger cargo being hauled, is made possible with an ordinary broom holder of the type carried by hardware dealers, 10-cent stores, and the like. Attach the broom bracket to the truck near the top end of the crowbar. Two pieces of strap iron or a sheet of tin at the bottom will keep the lower end from slipping out.—N. B. S.

3 LEAKS IN A RADIATOR CORE can be stopped efficiently with a little ordinary aquarium cement pressed into the holes in the core from both sides. The material is soft enough to be worked with a stick pushed through the front grille. It will set in contact with water, so it is unnecessary to drain the radiator.—F. J. B.

4 BATTERY-CABLE INSULATION that has corroded and begun to peel can be covered with old garden hose in a simple repair that may outlast the cable itself. Garden hose will usually slip over the fitting at the starter end of the cable, but in some cases the battery connection must be taken off and then soldered back after the hose has been put on.—A. W. H.



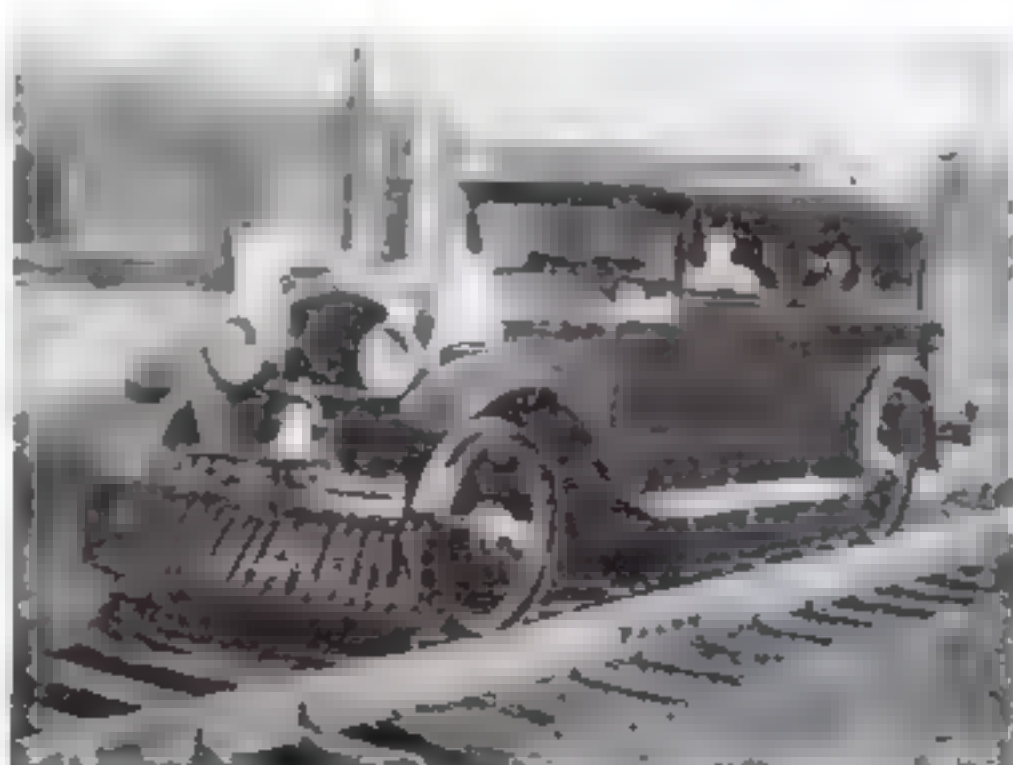
CYCLING UP HILLS is quite a bit easier when you don't have to pump. With this idea in mind, Yankee soldiers serving with the U. S. Army Air Forces somewhere in Britain invented a new type of horseless carriage—the "electrocycle" shown at right. Power for an electric motor is supplied by automobile batteries in the back, and the pedals are for supplementary use. A sidecar attached by cross members makes passenger service possible. The M.P. isn't giving out a ticket—he's just curious.



TO MEASURE TOE-IN, a gauge has been developed fitting any vehicle and requiring only one man to operate it. Chains suspend the gauge between the front halves of the wheels, and the pointer is set at zero. Then the car is moved forward, and when the gauge reaches a point at the rear of the wheels which is the same distance from the floor as before, the pointer indicates the amount of toe-in in inches.

TRACK INSPECTION in the New Ontario district of the Canadian Pacific Railways is done in an "auto-motive." This unusual vehicle has been adapted from a 1929 seven-passenger limousine. The tires have been replaced by flanged steel wheels, and secured below the front bumper is a miniature cowcatcher. A bell in front of the radiator and a loud horn complete the conversion. Riding the rails in this car is N. R. Krump, superintendent of the district, who finds it enables him to make inspection at places along the line where regular trains are not scheduled to stop.

A WETTING AGENT and detergent for automobile engines has been found to lessen frictional wear on parts and to increase motor tune-up. Although it is not a lubricant, the liquid has tremendous oil-carrying properties, and when poured into the carburetor and crankcase it quickly forwards the oil to valves, rings, and all upper cylinder parts. Hard coatings of cylinder-wall varnish are said to be dissolved by its solvent action as is grease, which acts as a binder for hard carbon. In zero temperatures, tests have shown the liquid lessens starting drag. It's said to be beneficial in new and reconditioned motors.



Gus Argues a Case in Court

HE BALKS A JAIL TERM WITH HIS OWN BRAND OF DETECTING

By Martin Bunn

JUDGE HODGKINS cut off a taxi driver's excuses with a thump of his gavel. "A red light means stop. Five dollars. Next case," he called and looked about his courtroom.

Then his judicial sternness gave way to a bright smile.

"Hello, there, Gus Wilson," he said loudly. "Come up here and shake hands."

Gus, a witness in a minor accident case, crossed the railed enclosure in front of the high bench and grasped the pudgy hand the Judge reached down.

"You haven't showed up for our little Saturday night pastime at the Park House for a dog's age," Sam Hodgkins told him accusingly.

"Too busy for poker these days, Judge," Gus replied.

"No excuse in this court," Judge Hodgkins rumbled with a wink. "Well, make yourself comfortable."

Gus sat down. The 300-pound judge drained a glass of water, refilled it, and banged his gavel again. "Next case!"

"Leonard Marshall. Charged with driving with undimmed lights . . .," the clerk droned.

Policeman Jim Devine stepped forward

with a tall, bespectacled young man by him.

"Your Honor," he said, "a complaint from old Miss Carver in Orchard Lane. Just before nine o'clock every night for the last week, while she was airin' her dog, a driver blinded her by suddenly putting on his bright lights. Last night I proceeded to Orchard Lane. At 8:49 a car approachin' with its headlights dimmed flashed up its headlights on reachin' a turn in the road 50 yards from Miss Carver's property. It was driven by this Leonard Marshall."

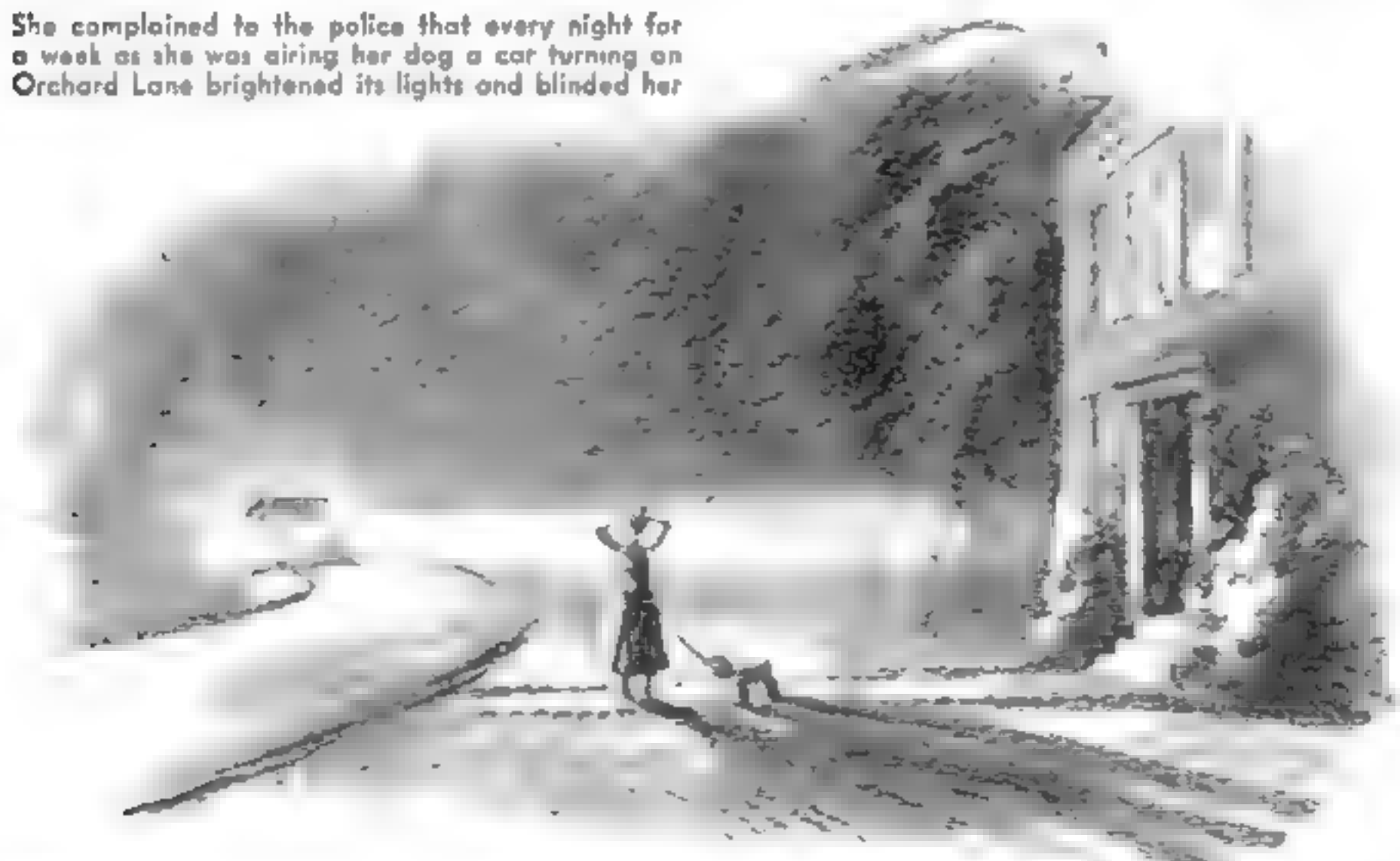
"Well," the Judge growled at the accused, "what have you got to say? Guilty or not guilty?"

Marshall's pale face flushed. "I don't know what to say, your Honor. When this officer stopped me my headlights were on full, but they were dimmed when I left home, and I didn't switch them. They went up by themselves—somehow they do that every night just as I get to that particular turn in Orchard Lane."

Someone laughed.

Judge Hodgkins' fat face flushed several shades redder than young Marshall's, and he hit his desk a mighty smack with his gavel and leaned forward. *[Turn the page.]*

She complained to the police that every night for a week as she was airing her dog a car turning on Orchard Lane brightened its lights and blinded her



"Young man," he roared, "the last defendant who got fresh with this court is just finishing up ten days. You are in contempt of court. . ."

Gus Wilson stood up. "Your Honor," he interrupted, "may I say something?"

Hodgkins looked at him. "What is it, Gus?" he asked.

"I've seen cars do a lot of queer things," Gus said. "I'll admit Mr. Marshall's explanation sounds phony, but it isn't impossible that the lighting circuit could act that way. May I suggest you have the car examined?"

Judge Hodgkins gently rubbed his bald head. "The court accepts Mr. Gus Wilson's suggestion, thanks him for it, and appoints him to examine Leonard Marshall's car," he said after a moment. "Case continued until ten o'clock tomorrow morning."

WHEN Gus finished his case in court, he found Marshall and a '39 sedan waiting for him at the Model Garage.

"Mr. Wilson," Marshall said, "it was mighty white of you to help me. I'm in bad, but I was telling the truth."

"Well," Gus told him, "we've got to find the trouble. When did it first begin?"

Marshall ran long fingers through his hair. "About a month ago," he said, "my beam-indicating light burned out. I didn't do anything about it, because I was busy, and ordinarily I don't use my car at night. But just now I have to. I'm a chemist at the Johnson and Fredericks plant, and for the past week I've had to go down there every evening about nine o'clock to check on a test I'm making on a new material.

"The first night I drove to the plant, just before I got to the Orchard Lane turn where Miss Carver lives, my lights went up. I tried to dim them, but the dimmer wouldn't work. I was in the lab for half an hour. Before I started home I tried the lights again, and they dimmed. But after I'd driven a few blocks they flashed up again, and working the switch wouldn't turn them down.

"I figured that the trouble must be either a loose connection or a short, so I went over the lighting circuit, but I couldn't find anything. Then I thought it must be something in the headlights, so I took them apart and found a lot of side play in the contact pins in the base of one socket. The

insulation on the wires had pulled back and exposed the copper for about half an inch. That made me think the wires might have touched when they were jarred. I wrapped friction tape around them, replaced the headlights, and tested the lights. The dimmer switch worked—I thought things were O.K."

Gus nodded and asked, "Then what?"

"The next night," Marshall told him, "I found I didn't have the trouble licked. The lights were all right when I started out, but when I got to that turn in Orchard Lane they flashed up again.

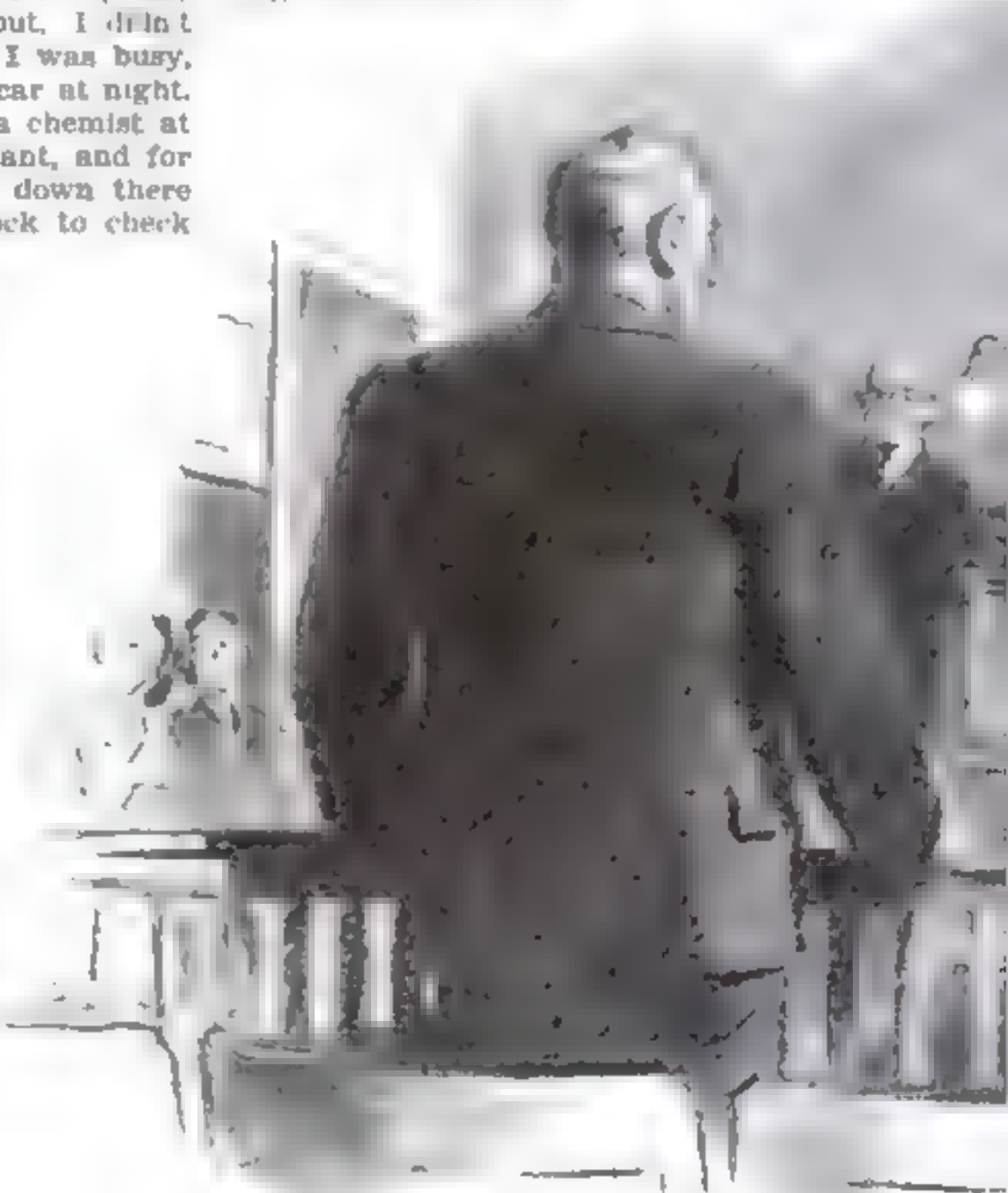
"Well, just on a chance, I got a new dimming switch the next day and installed it. It worked fine in the garage, but when I drove to work, the same thing happened."

"Let's have a look at that bus," Gus said. "By the way, had any fuse trouble?"

"Yes," Marshall recalled, "I forgot to tell you about that. Night before last the fuse burned out—ends melted right off. I put a new one in."

Gus installed a beam-indicating bulb first. Then he checked the lighting circuit. There was nothing wrong. A check of the voltage regulator showed it in working condition. Then Gus tried the lights, and found that they dimmed when he pressed the switch.

"They always dim all right—in the garage!" Marshall said.



Gus filled his pipe. Then he said: "When a car that is runable has you stumped, I've always found that the best thing to do is to run it and see what happens."

When he got into the driver's seat he noticed the zero showing on the speedometer's tenth-mile indicator. "How far is it from your house to where Jim Devine pinched you?"

"A quarter of a mile," Marshall said.

Gus started the engine, switched the lights on, dimmed them, backed the car out of the shop, and headed up the road. Marshall noticed that he was watching the speedometer. The numerals on the tenth-mile indicator band moved slowly. When the "3" was close to the center of the aperture a ruby spot glowed at the top of the dial.

"They're up again!" Marshall exclaimed. "That's when it always happens!"

"O.K.," Gus said calmly. "That's what I wanted to make certain of. Now I know what the trouble must be—something is acting as a thermostat."

He switched off the lights, turned, and drove back to the Model Garage. In the shop he began taking the headlights apart. "It's heat that is making your lights act queer,"

he told Marshall, "and the only place that heat could affect them that way is in the bulbs themselves."

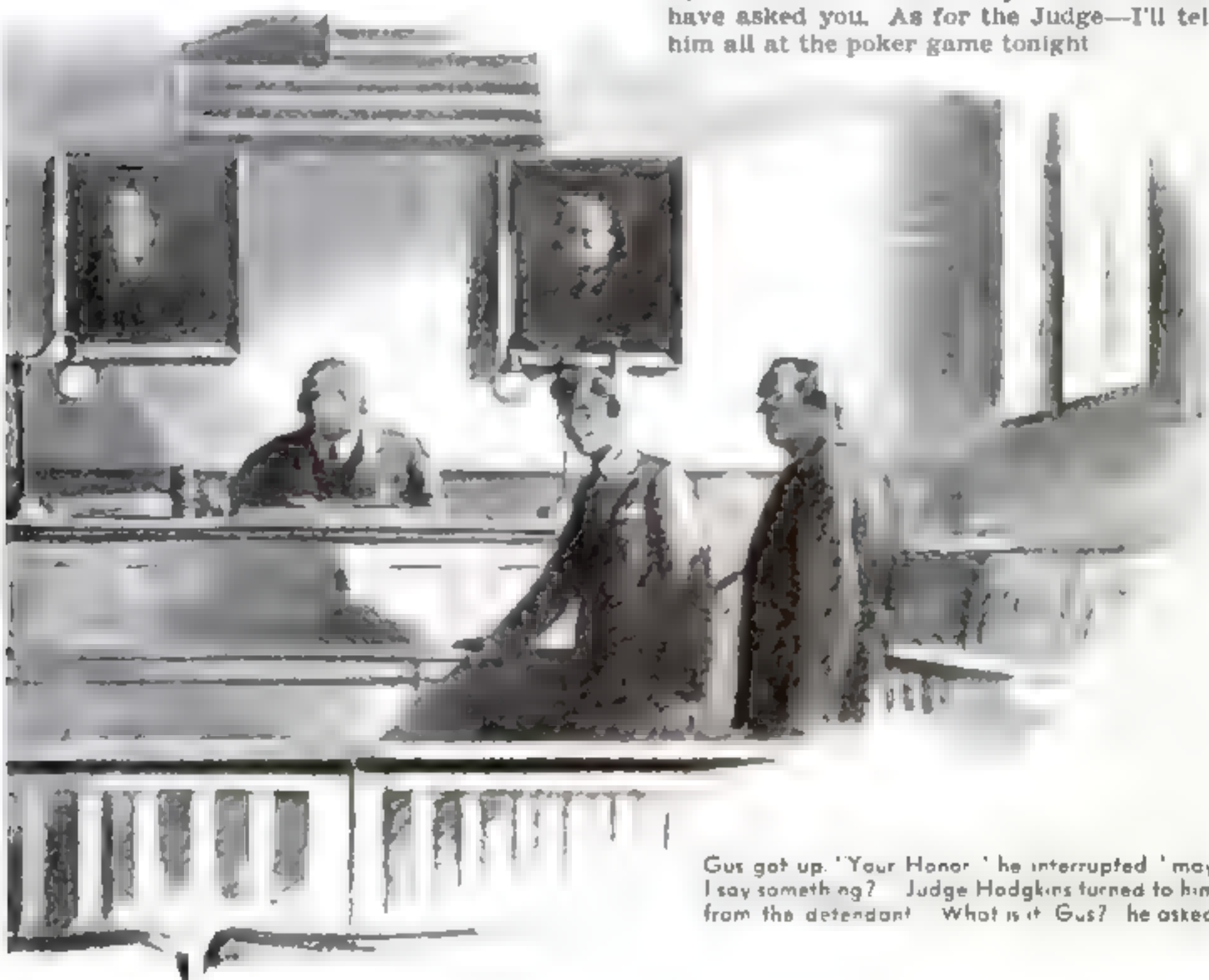
He tested the dim filament of one bulb with an ammeter. For a little over half a minute the reading showed normal current consumption. Then the hand jumped; the lamp was drawing twice the current!

"That beam-indicator light is on, isn't it?" he asked Marshall. "I thought so! Let's see this lamp. . . Yes, that's it—both filaments burning. Well, that locates the grief."

He examined the lamp. "Nothing wrong with the filaments," he decided. Carefully he removed the base. "There's the trouble," he told Marshall. "Those filament leads almost touch. When the wires get hot, they expand and touch, causing a short, and as the headlight bulbs are wired in parallel, that makes both filaments of the other lamp burn, too. Naturally, with all four filaments burning, the dimming switch doesn't work. . . When did you put these headlight bulbs in, anyhow?"

Marshall's face got red. "Why, just before I had my first trouble," he said. "I should have told you that, shouldn't I?"

Gus grinned. "That's one way of putting it," he said. "The other way is that I should have asked you. As for the Judge—I'll tell him all at the poker game tonight



Gus got up. "Your Honor," he interrupted, "may I say something?" Judge Hodgkins turned to him from the defendant. "What is it, Gus?" he asked.



This homemade clamping jig, used with double wedges, is excellent for gluing picture frames. Open corners permit truing of miters.

Picture Frames You Can Make with Hand Tools

FRAMED pictures, whether hung singly or in twos and threes, are of considerable help in the decorating scheme of many rooms. Their pleasing presentation depends upon the wall area to be covered, the size of the pictures and of the frames, and their position. An easy and quick way to determine the best size for certain wall spaces is to cut several rectangular pieces of cardboard of various sizes and have someone hold them to the wall while you view them from a distance.

The sizes you try, however, must be in keeping with the pictures you wish to frame. In some instances a picture may fill its entire frame to advantage, but most often the best presentation is with a border of matboard of white, off-white, or a shade that harmonizes with both the picture and the frame.

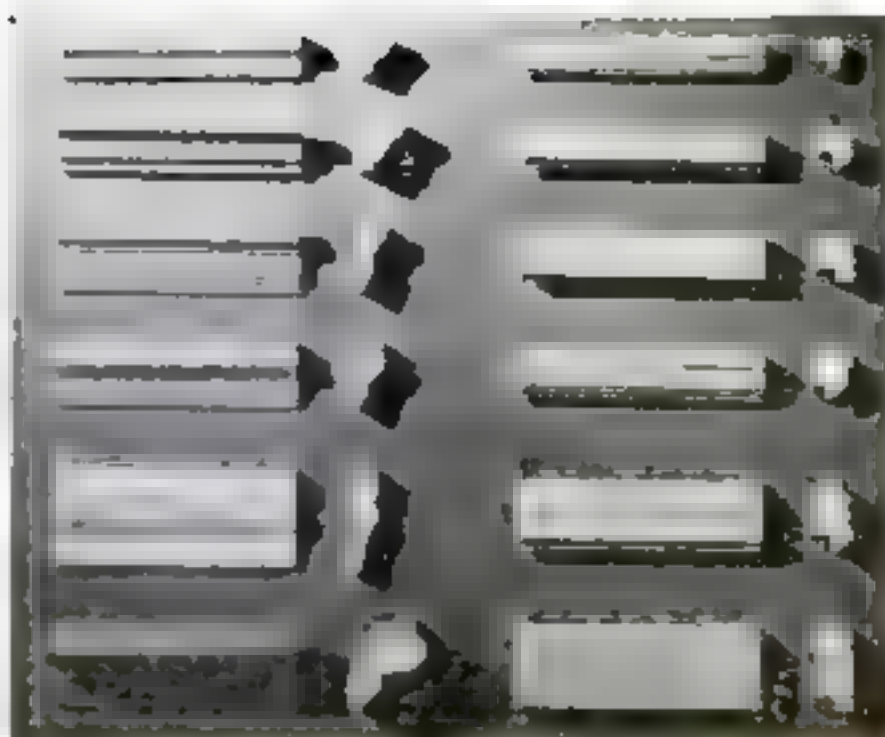


Where stock molding is too thin to permit rabbeting for the glass, picture, and cardboard backing, the rabbet is formed with a $\frac{1}{4}$ " thick strip nailed and glued to the back $\frac{3}{8}$ " from the inside edge. The strip is trimmed flush at the outside. Strips can also be used in building up frames of some types.

Width of border is a matter of taste and is immediately apparent to the artist or professional decorator. Generally the width of the side borders is made equal to that of the top margin, and a trifle more width is allowed at the bottom. This creates a sense of balance in the picture and frame as a whole. As a suggestion, one good size for a picture, say, $6\frac{1}{2}$ " by $9\frac{1}{2}$ ", would allow $2\frac{1}{2}$ " borders at the sides and top and $3\frac{1}{2}$ " at the bottom. In general, strong, colorful, powerful pictures demand wide mats, while delicately toned pictures having light areas predominating show to best advantage with narrow margins.

While it is sometimes possible to obtain ready-made frames to suit your requirements, it is not difficult to make a frame yourself, and when you finish you will have at moderate cost a really fine piece tailored just so for the best possible display of your favorite picture. You will have the fun also of experimenting with types of moldings, mat sizes, colors, and the like. Undoubtedly you will wind up improving the decorating scheme of your home by framing many more beautiful pictures than you would have thought possible. These may include photographs you have taken and enlarged yourself, prints or paintings you have acquired, and many of the handsome color prints of fighting planes and the like that appear in the magazines.

Making the molding. The width and shape of the molding, as well as its color and texture, should naturally bear a close relationship to the picture it is to frame. Artists making their own frames will know this instinctively, but it is difficult to give any definite rules that will serve the average



Moldings at the left are standard shapes carried by lumberyards. Those of the right are designs made on a drill press from common $\frac{3}{4}$ " thick stock

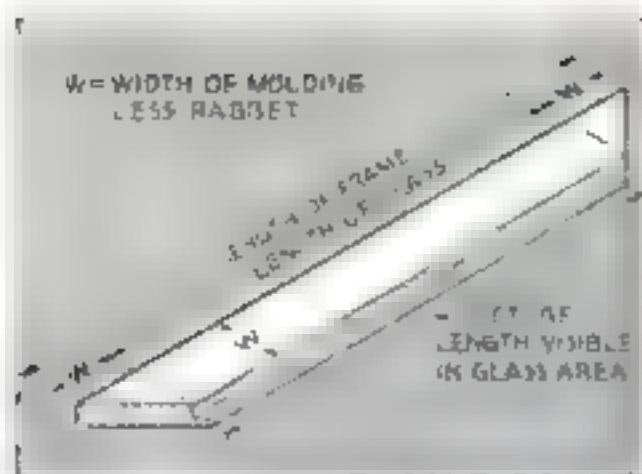
craftsman and apply in all cases. In general, however, the larger the picture the wider the molding required, and dark tones in a picture usually call for dark-colored frames.

Molding of various types can be obtained at a lumberyard, which may often have beautiful special moldings in stock, or they can be made in the home shop with a shaper, circular saw, high-speed drill press, or hand tools. A hand plane is sufficient for beveling or rounding an edge of a simple frame. Power tools or a rabbet plane are used to



In using a drill press for shaping picture-frame stock, clamp a long table and fence to the regular drill-press table. Always feed the work with a push stick for safety. Pressure is applied with a notched block directly in front of the cutters

Special moldings of your own design can be made with a hand tool called a scratch stock. It consists of two blocks of wood notched to fit the molding stock and bolted to hold the shaped blade, as shown in the drawing. The blocks on the bench steady the molding



make a recess in the back for receiving the glass, picture, and cardboard backing.

Beads and other curved designs can be made by hand with a homemade tool called a scratch stock, which is shown in one of the photographs and a drawing. This tool is made from two pieces of hardwood about $\frac{3}{8}$ " thick and a thin steel blade. The wooden pieces are notched the width and thickness of the molding to be made and are bolted together so as to hold the cutter tight.

This cutter may be a piece of old saw blade, and it can be shaped to the desired design on a grinding wheel or with files. After grinding or filing, the burr should be rubbed off on an oilstone. In use, the blade is pushed into the block just far enough for a light cut, and is lowered gradually for succeeding cuts until the full design is formed. The block itself should be in contact with the bench for the whole operation.

A scratch stock works best on fairly hard, close-grained woods such as whitewood, birch, gum, maple, beech, mahogany, and walnut. The work is clamped securely to the bench, and the scratch stock is pushed away from the operator. Sanding is necessary for a smooth finish.

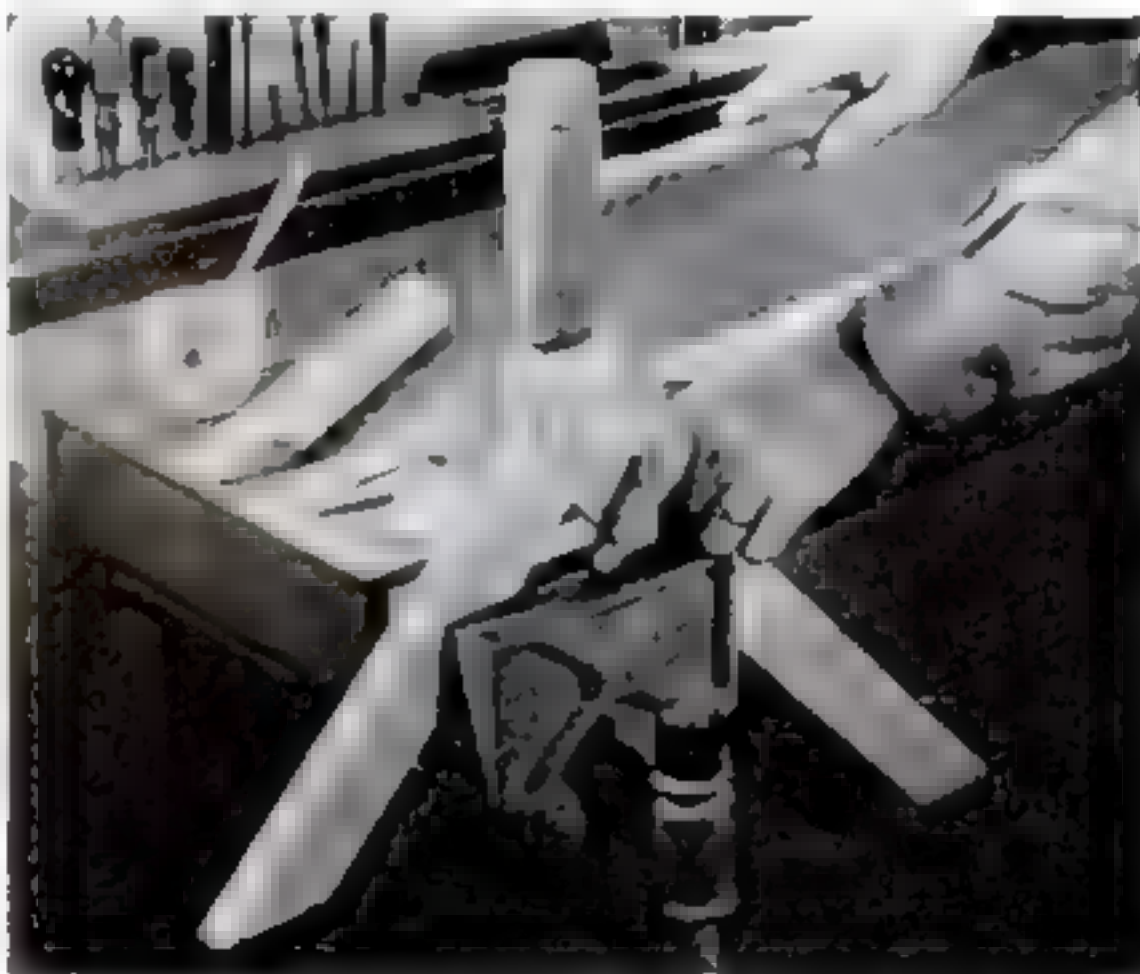
Another excellent tool for shaping moldings is a modern, high-speed drill press. Use the machine at its highest speed, 5,000 r.p.m. or better, for clean, smooth cuts. An extra-long table and fence, as shown in one of the photos, makes handling easier, and the work should be fed with a push stick as a safety measure. Pressure is applied with a notched block directly in front of the cutters. An assortment of three to six cutters is sufficient for a variety of designs.

When molding is to be shaped, it is best to



This homemade miter box is provided with an extra-long bed that is useful when cutting the several pieces of a picture frame to exact length, since a stop block can be nailed to the bed. The box has two 45-deg. sets of slots and one 90-deg. set for taking the saw. Its bed can be clamped to the bench for added rigidity.

Splines and slip feathers are often used to strengthen corners of a frame. The former are inserted and glued in when the joints are assembled, and the latter may be glued that way or be tapped into the saw cuts after the glue has dried. Clamp the joint carefully in a vise as shown below, and dress the feather edges flush when the glue has set. The grain runs at right angles to the miter cut.



cut the rabbet in the back first. On moldings obtained at a lumberyard, nail a wood strip to the back about $\frac{3}{8}$ " from the inside edge to act as a guide if a rabbet plane is to be used. Where stock molding is too thin to permit rabbeting, $\frac{1}{4}$ " thick strips can be glued and nailed to the back about $\frac{3}{8}$ " from the inside edge to form the rabbet. The strip is, of course, made flush with the outside edge.

Cutting the miters. This is done with a power tool or a handsaw and miter box, which may be homemade if you do not have



Sanding mitered cuts provides a smooth surface for glue. The jig shown above has an adjustable fence that can be set at any angle and held steady with a bolt and wing nut. It is raised off the base with $\frac{1}{2}$ " stock. A piece of $\frac{1}{4}$ " plywood glued to the bottom of the sanding block extends $\frac{1}{4}$ " beyond the face for a sliding surface

Doweling is frequently the best method of reinforcing a heavy or a large picture frame or a frame intended for a mirror. Holes for the dowels are bored at right angles to the miters, and can be spotted exactly with dowel centers or brads. On a built-up frame where an extra strip can be added at the edge to hide the dowels, holes can be bored all the way through an assembled joint



one of the commercial units. It is well to clamp the molding to the side of the box while making the saw cuts, and even then the miters may not always fit perfectly.

A simple way to repair a faulty miter joint is to clamp the pieces to a board so that they are at right angles to each other, and then make a saw cut right through the joint to remove unevenness from both sides. One or two cuts at most will usually be sufficient for a perfect joint. Fit one corner of the frame at a time and number the pieces, and finish with sandpaper to smooth

the surface for better gluing. A jig for sanding miters is shown in one of the photographs.

Be careful to see that the two opposite sides of a frame are exactly the same length, or the corners can never be made square. To find the length of a molding, add twice its width minus the rabbet to the dimension of the picture or glass on that edge.

Gluing the frame. Miters in themselves are not strong joints, so great care must be used. It is well to apply a thin coat of glue size to the surface to help fill the end-grain pores so that the final coat of glue will not be so greatly absorbed.

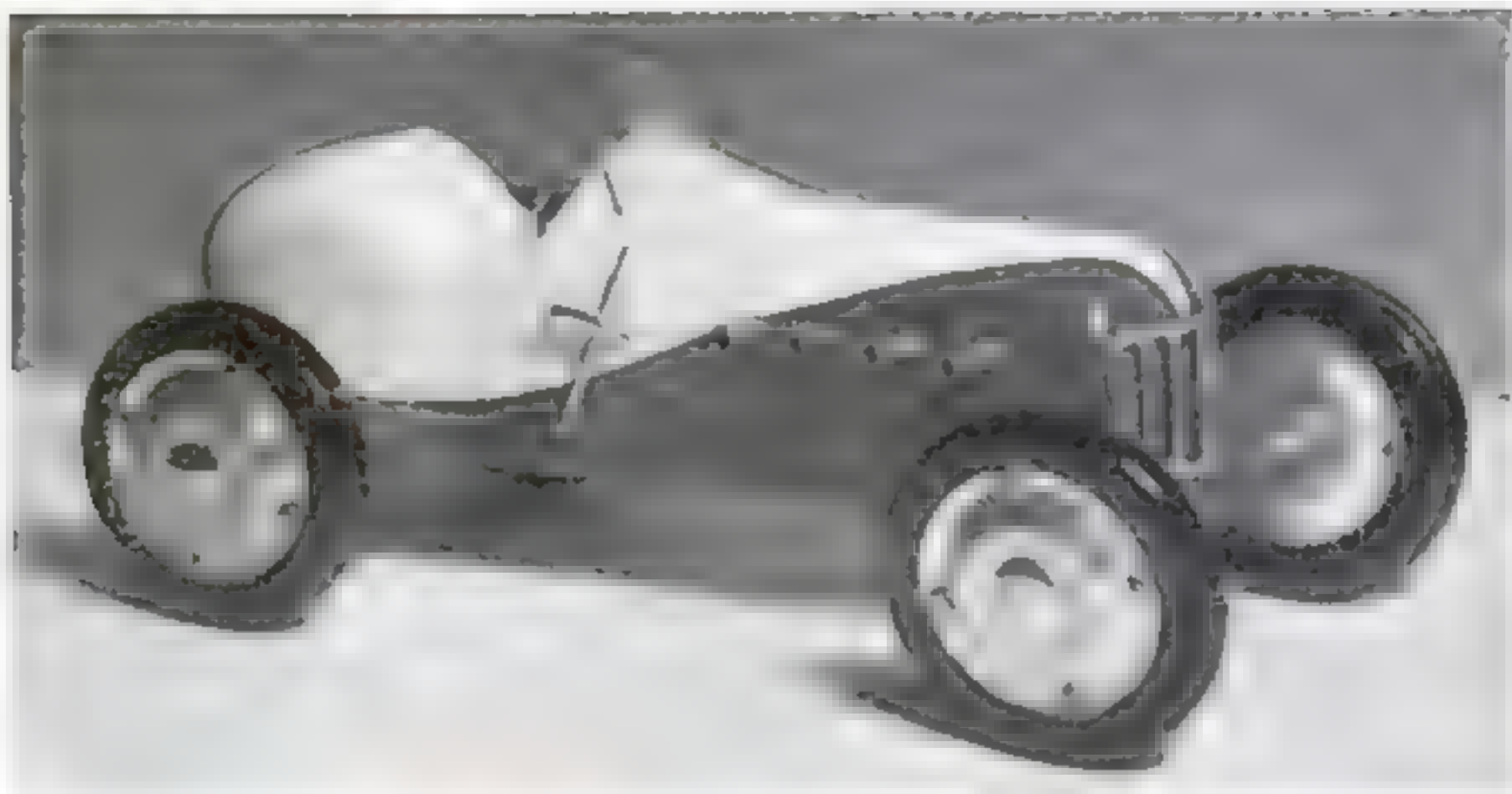
Several types of clamps work well in making a picture frame. One of the simplest of the homemade variety is shown in a photo. It consists of four strips nailed or screwed to a wide board, a bench, or even the floor in the shape of a frame with open corners. Place paper under the glued edges of the frame, and insert the assembly in the jig; then drive in four pairs of wedges, as shown, to bring even pressure on both sides of the joints.

Reinforcing the joints. Glue alone is rarely strong enough to hold the mitered corners of a picture frame, so nails, splines, slip feathers, or dowels are usually added. Nails are always satisfactory, especially if special picture-frame nails having great holding power are used, but the other methods sometimes appear neater.

Grooves for splines may be cut in the face of each miter, or saw cuts may be made through part of both sides of

the joined pieces and a thin strip glued in, as shown in a photo. This slip feather is, of course, trimmed off flush after the joint has dried. Use an ordinary hand saw for making the cuts. The grain of the spline or feather runs at right angles to the mitered cuts.

Dowels are especially useful on large frames, such as those holding heavy mirrors. Bore holes for the dowels at right angles to the miter. They can be made to coincide by spotting with dowel centers or brads. The holes can be bored straight through if facing strips are added to the frame edges.



MODEL RACING CAR



By **FREDERICK HUMPHREY**

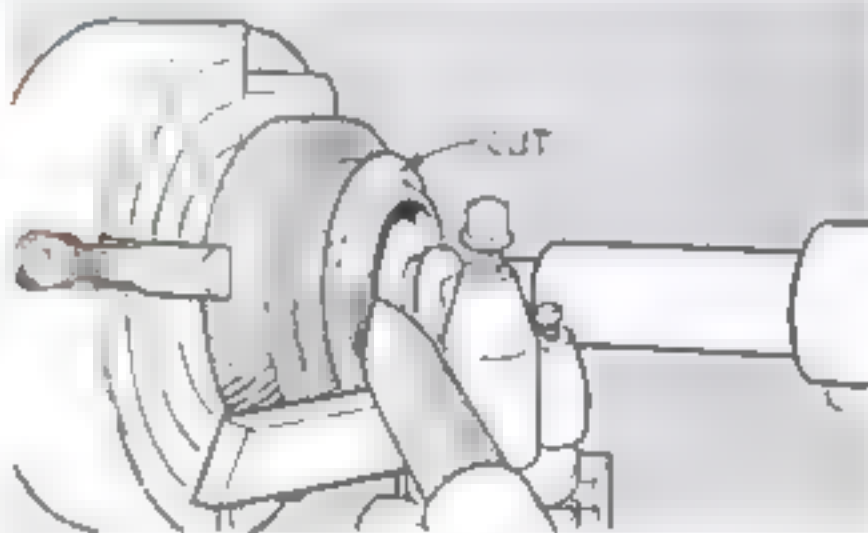
CARVED from a block of clear, soft 2" by 3" stock, this smart model racing car makes a sturdy toy. The one shown has polished wheels that are an interesting project in lathe spinning, but suitable wheels can be bought ready-made at a model-supply house or shaped from pieces of rolling pin.

Saw and carve the body, notching the underside for the two axle members; then rout out the inside with a bit to help in carving the seat and floor. Glue on the axle housings and sand smooth.

The radiator grille and steering wheel are built up of short pieces of 3/32" wire soldered together, buffed, and coated with clear lacquer, or a fair grille and steering wheel can be cut from cardboard. Eight 3/4" pieces of 1/4" copper or other tubing are



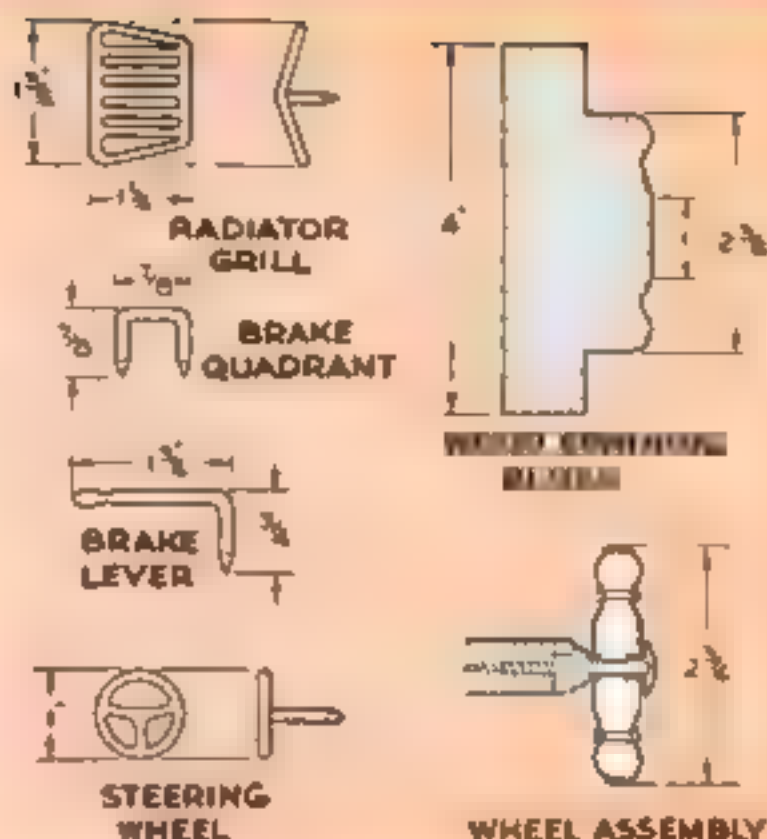
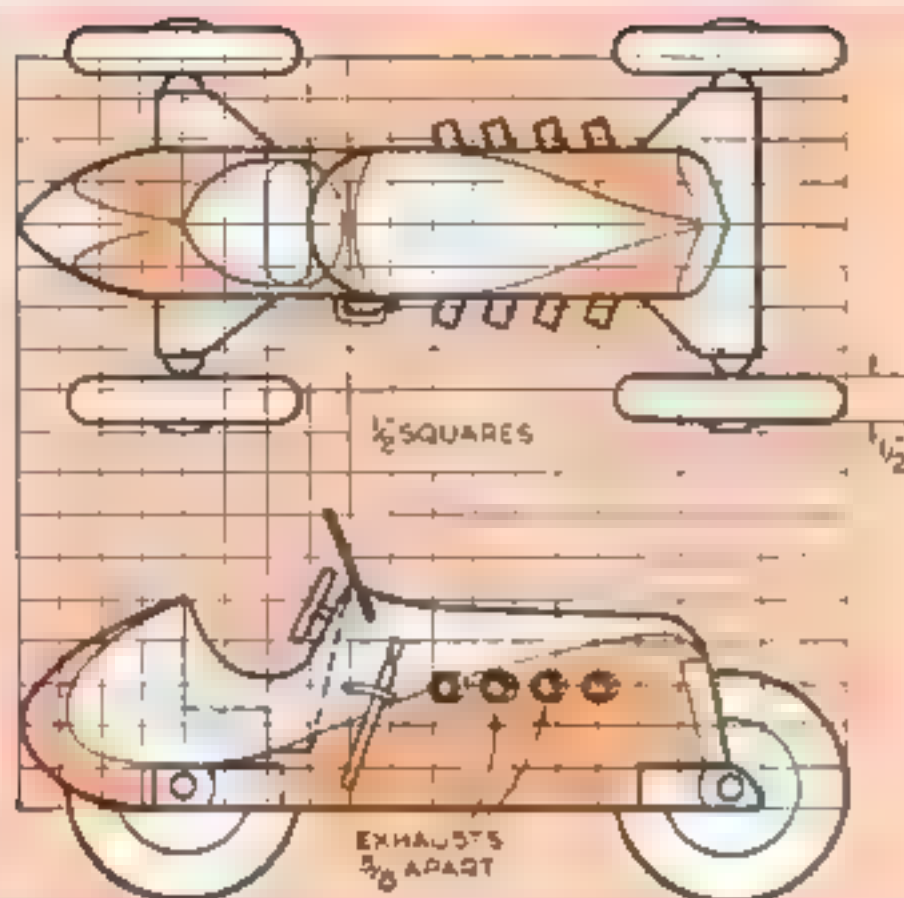
These are the parts needed for this model racer



Disks may be spun for wheels on a hardwood block

driven in for exhaust ports. A handle can be filed on the sharpened wire that forms the brake, while the brake quadrant may be shaped from wire or made from a staple. Clear plastic or celluloid is fitted into a groove for the windshield.

If metal spinings are used, two will be needed for each wheel, one slightly smaller than the other to fit inside, as shown in a drawing. Cut eight 3 1/4" disks of 24-gauge



or thinner steel, copper, brass, or aluminum, or use tin-can stock. Both copper and brass should be annealed by heating to a dull red and quenching in water.

Chuck a block of hardwood and turn the profile shown. Place one disk against this block, hold it with the tailstock center (preferably ball-bearing) tightened against a small hardwood or metal turning, and lubricate the center. The tool is a 2' length of 1" diameter hardwood tapered to a rounded and polished end. Rest it on a tool holder in a metal-lathe tool post, or contrive a post that will fit a wood-lathe tool rest and bring the horizontally held tool to the midpoint of the spinning.

Soap the face of the disk and dip the tool in water occasionally to keep the soap slippery. Start spinning near the center, stretching the metal outward as you work toward the edge, which can be cut to size later, if necessary, with a parting tool. Mark the center with the tailstock center before removing the disk.

Spin four disks to the dimensions shown; then take a light cut to decrease the diameter of the block and spin the inside four. Drill for axles, which may be wire or drill rod, and for tire bolts. Put small acorn nuts on the axles between the wheels and body, and solder the top halves of snap fasteners to the axles as hub caps. Paint as desired.

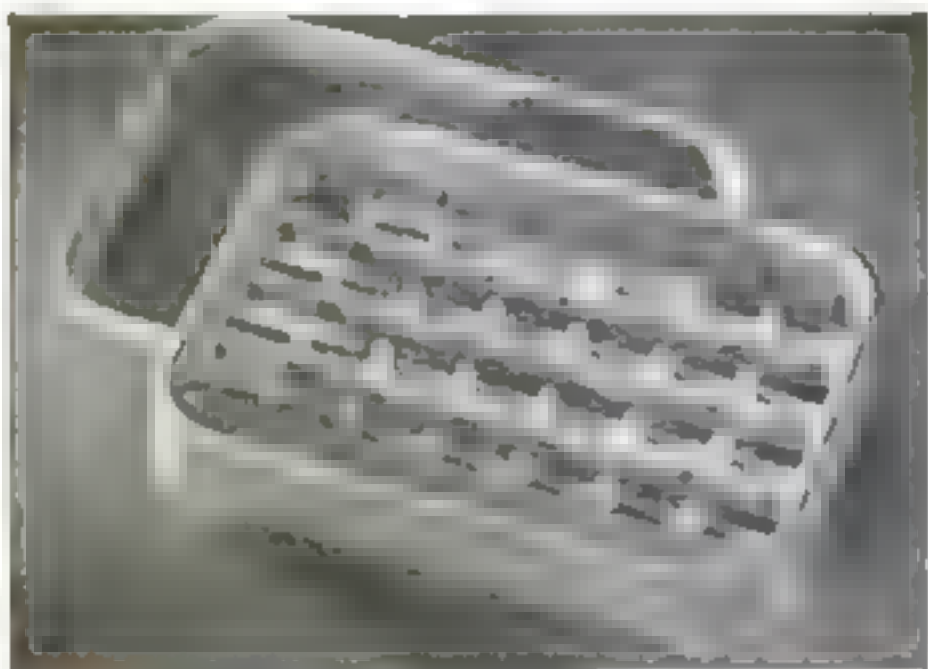
Soldering Iron Helps in Shaping Model Parts from Acetate



ACETATE material, softened with hot water, becomes very pliable and can be handled and molded readily for model-making parts. If difficulty is experienced with curves or bends where they are confined to very limited areas, try holding an electric soldering iron in a vise and pressing the material around the hot shank. Sufficient heat will be transmitted to the place it is needed and will permit bending to the proper curvature. When the material cools, it will retain the curves given to it.—MICHELE DE SANTIS.



BAMBOO is now being imported from Hawaii to make such attractive home decorations as the flower holder shown above. Contrasting with the smooth, polished finish of the wood is heavy cord bound around the bottom of the vase. The handle—similar in appearance to that on an old-fashioned handled candlestick—is a ring, also covered with cord. The vase was shown at the annual Gift and Art Show in Los Angeles.



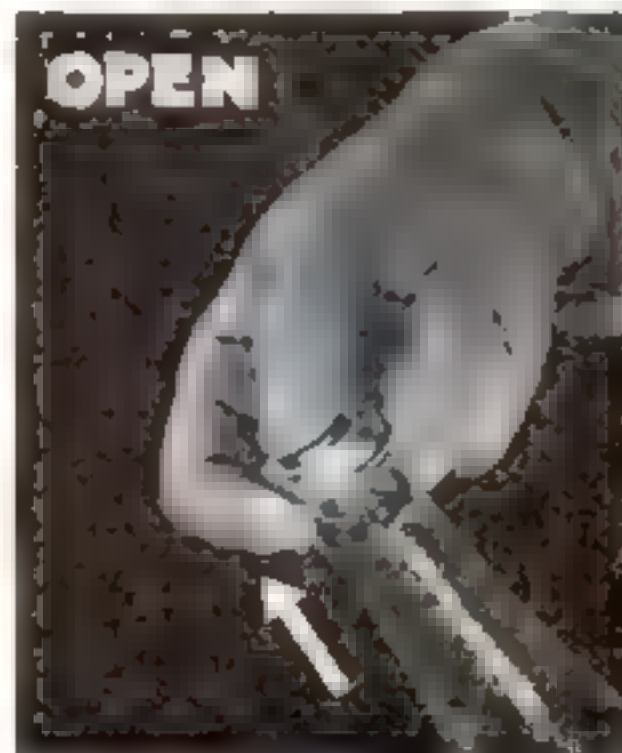
AIDS TO *Modern Living*

JUST ONE ICE CUBE or as many as you need can be quickly and easily removed from the tray shown below. Resting in a frame are a dozen separate cups in which the water is frozen. You merely lift out the number of cups required, press their flexible sides, and the ice is freed. This device eliminates the arduous task of holding a tray under running water or displacing its entire contents with a lever. Shells in which the freezing takes place are made of a clear plastic. This time and ice saver is suitable for standard refrigerators.



THIS SOAP TRAY has a drainer that keeps soap high and dry and thus makes it last longer. Instead of lying in the water left on it and further dissolving, the soap bar rests on a rack placed within a dish, and the water runs right off. The two-part tray is made of plastic which is of various shades to harmonize with kitchen and bathroom tiles, and won't break. Its size is convenient for placing the tray over a double-outlet faucet.

BOTTLES OF SODA WATER and other carbonated drinks can be kept from losing their pep between uses by capping them with this stopper. The cap is made of metal and works by means of a push button surrounded by a collar. When inserting the stopper, as shown in the first photo at right, press down on the rim. This causes the teeth projecting from its lower edge to grasp the bottleneck firmly and seats a rubber washer against the top for an airtight seal. Push button to remove cap.



CRAFTSMAN'S PROJECTS TODAY . . . HEIRLOOMS TOMORROW

Graceful Ladder-Back Chairs

COLONIAL FURNITURE ADDS CHARM TO ANY ROOM

By Franklin H. Gottshall

LADDER-BACK chairs retain their popularity because of their simple and sturdy construction and lack of ornamentation. Two well-liked types are the arm chair with four slats and the rocker with its gracefully curved back. One or more side chairs may be made as well. Follow the design of the arm chair, leaving off the arms and finishing the tops of the front legs like those on the rocker.

To build the chairs, first turn the back posts, starting at the center and working toward the ends. Do all turning on a post the same day to avoid the possibility of warping in the lathe. Hard maple is suitable for posts and legs, while sycamore or some other figured wood is best for slats. Use kiln-dried stock and peg the glued joints with $\frac{1}{4}$ " or smaller dowels. Drilling for these pegs is easily done with a portable electric drill used with a depth gauge made from a large dowel.

After each back post has been turned, score rings at exact locations of holes and mortises with the point of a skew chisel. These scores will add to the appearance of the chair and will aid in locating the joints accurately. After turning the back posts for the rocker, trim them with a drawknife to the shape shown in the drawing. Turn the front legs next, and then turn the rungs, or turn shoulders at the ends of hardwood dowels if the proper size is available. Take care to turn the shoulders on the rungs accurately, as this will help in getting the seat angles and the slant of the back posts.

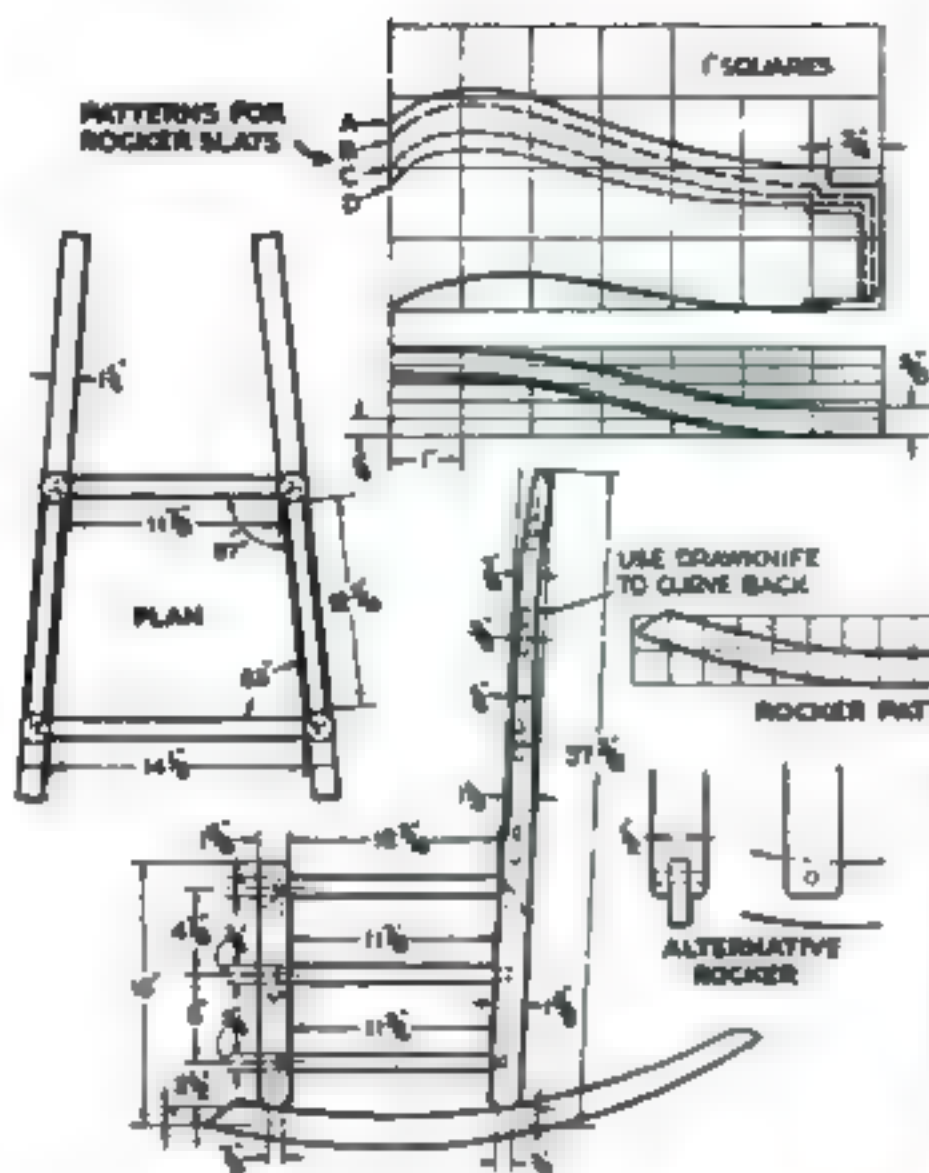
Bore the legs and back posts for the front and back rungs and mortise the posts for the slats. Holes for the side rungs are not bored until after partial assembly. The front and back frames are next fitted and glued separately. When the glue has set, drill for dowel pegs and clean up the pieces.

Bandsawing the face and back of the

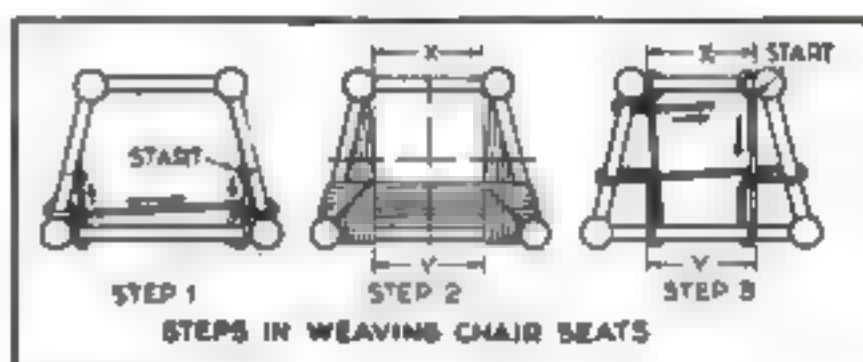
These early American chairs with their high, graceful backs follow faithfully the spirit of Colonial furniture. The construction is simple, but careful joining is an essential

Rush-type seats woven by hand are sturdy and handsome. The stately arm chair will lend charm to almost any room, while the rocker will serve in a bedroom or near a fireplace





Weaving is done with a tough fiber cord that resembles rush and is much easier to handle



length of cord, tying it firmly to the back rung to start. If the rungs on the side should be filled before the others, continue from front to back until all spaces are filled. A knot can be tied under the seat where it won't show if the end of a cord is reached before the weaving has been completed.

Finish the seat with a stuffing of newspaper cut into long, narrow strips and pushed under the bottom layer of cord—there will be three layers—turning the chair bottomsides up to do so. Stuff until the seat is well stretched and even, but avoid overstuffing.

For a natural finish, shellac the chair and rub smooth with steel wool; then apply and wipe off a stain coat of turpentine mixed with a small amount of burnt umber. After this has dried, apply two coats of floor varnish and a final coat of sateen varnish, which dries with a semigloss. Two coats of floor sealer will toughen the fiber in the seat.



Holes for side rungs are bored in a jig after partial assembly

Use of a belt sander will speed up the shaping and smoothing of the delicately curved slats



Adding a strip will correct the angle of the jig for the rocker

Holes for peg dowels are drilled in glued joints. A large dowel on the bit acts as a depth gauge



Recipe for Successful Gluing

HOW TO PREPARE THE RIGHT WOOD FOR THE RIGHT PLACE

By Edwin M. Love

GLuing is one of the strongest and neatest methods of fastening employed by the woodworker. Tight joints held with a good glue will often withstand a pull of as much as 700 lb. per square inch and are frequently stouter than the wood itself. Glue enables the cabinetmaker to turn out handsome pieces with surfaces unmarred by nails or screws. Without it, fine veneering would be impossible.

For successful gluing, three things are important. The glue must be good, the joint must fit accurately, and allowance must be made for shrinking and swelling.

What is a good glue? The home-workshop owner has a choice of good glues, and may be guided by the ease with which they can be applied or by their particular suitability for the job in hand. Most frequently used in woodworking are animal glue, which is heated and melted as needed, fish glue, a liquid, and casein and resin glues, both powders to be mixed with cold water as needed.

Why should joints fit accurately? Glue penetrates the wood, forming hundreds of tiny keys between the fibers to bind the joint. It will fill gaps in a loose-fitting joint, but it cracks when hardened in air and the keys break.

How is warping offset? Most wood is kiln-dried and is subject to swelling on reabsorbing moisture even after it has stood in the lumberyard. Other wood may not be dry enough and will shrink in the drier air of the shop. When lumber is stacked in a solid pile to conserve space in the shop, adjustment sets in slowly, affecting the exposed ends and the top boards first—or the bottom boards on a damp floor. Boards stood on end are likely to be even more distorted, the lower ends swelling through absorption of moisture from the floor, and the upper ends shrinking in warm air near the ceiling.

Much of this can be avoided by sticking, that is, by placing narrow strips between boards piled flat on top of each other to allow circulation of air. The weight of the boards themselves will often help to prevent warping, but it is a good idea to add extra weight or to use clamps. The bottom board should, of course, be raised on blocks or a rack.

Can warp be corrected? Sometimes a board can be straightened by laying it cupped side down on damp ground, but if the set is permanent it may warp again when it dries. If a tendency to warp is discovered, try clamping two boards together with the convex side exposed to action of the air.

Do log-cutting methods affect warping? Shrinkage is principally in the plane of the annual rings, and a board plain-sawed near the outside of a log will shrink and swell more than a center board where the rings are at right angles to the surface. Usually the sap side contains more moisture than the heart side, and a board will tend to cup to the sap side.

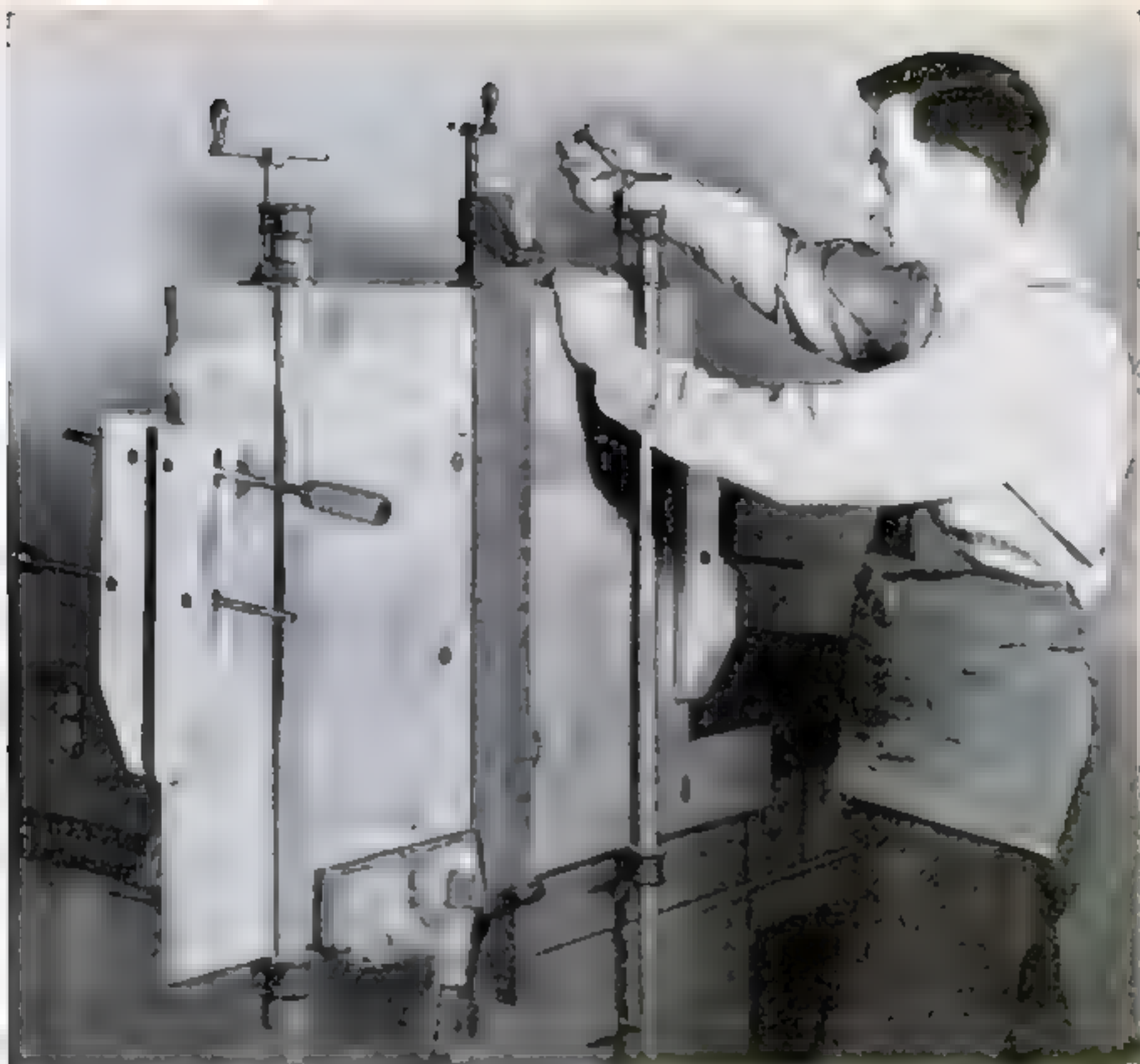
Quartersawed lumber is subject to less change than plain-sawed. The best quartersawed boards are cut at right angles to the rings, but there is more waste. In some methods, as shown in a drawing, waste is reduced, but the full value is lost when the cut departs from a true radius. The cut will show plainly on the end grain.

Will glue hold against shrinking? The force exerted by shrinking is tremendous, and even the best glue cannot always hold against it. A good practice is to cut lumber to be glued roughly to size several days ahead to let shrinkage become equalized. The boards are then trimmed accurately for joints just before being glued.

How are boards glued edge to edge? Arrange the pieces with the heart and sap sides alternating and the grain running in the same direction. The glued assembly, if it warps, will assume a slight waviness rather than a deep arch and can be planed flat without much loss of thickness. If the pieces are cut from the same board, this arrangement can be made by turning the alternate boards end for end, thus reversing the sides.

Since freshly cut ends may not be as dry as old ends, they may shrink more and faster, tending to open the joints. Even when all the ends are freshly cut, this may occur with the ends shrinking faster than the center sections. Many woodworkers counteract this by planing the edges of the boards so that the ends will be absolutely tight and true and the middle slightly open.

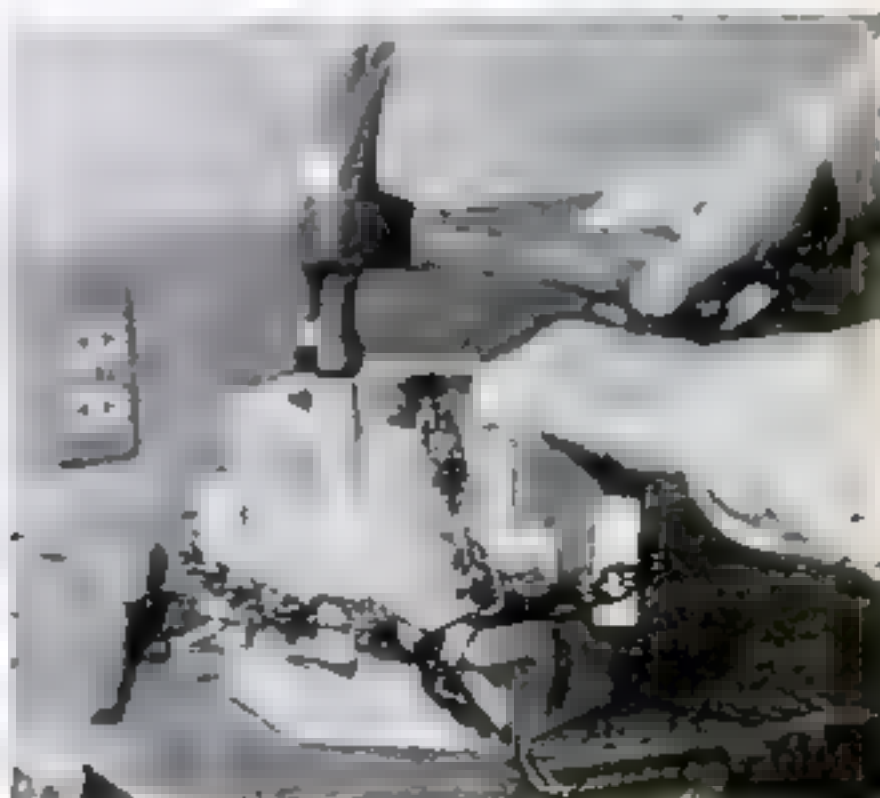
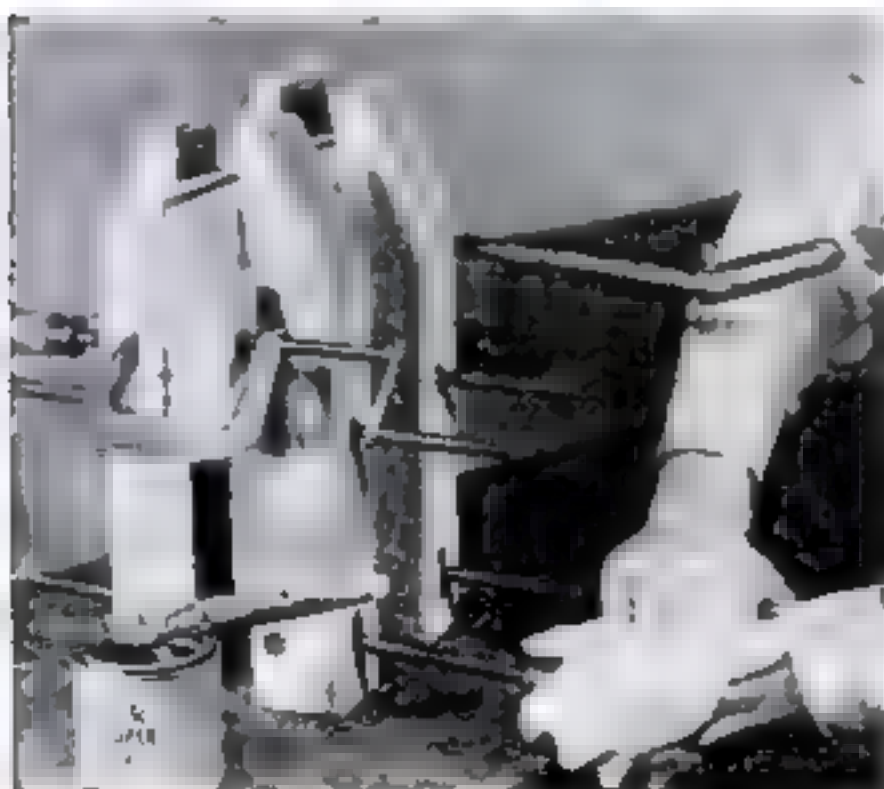
Will boards glued face to face warp? This

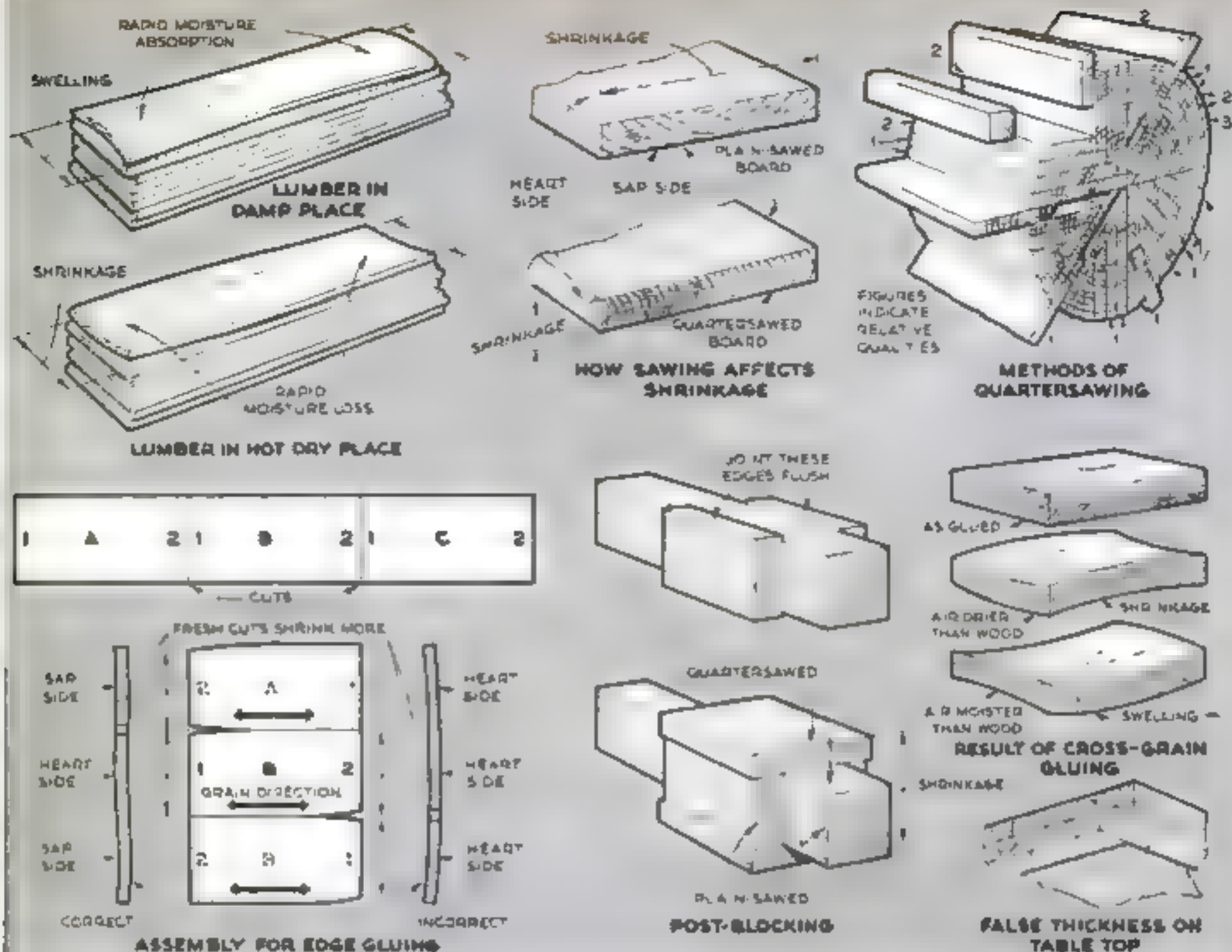


GLUING BOARDS EDGE TO EDGE is done with bar clamps on pipes or wooden bars. Warping is minimized if the boards are assembled with heart and sap sides alternating, and shrinking is offset by planing the edges so the ends fit tightly—the clamps pull the centers in. Hand screws prevent buckling

FACE-TO-FACE GLUING with hand screws and C-clamps. Lay the sap or cupped sides of the boards against each other with the grain running parallel and apply even pressure across the faces

CLAMPING A POLYGON is an unusual job that can be accomplished with a chain and bolt as shown below. The wedges driven between the blocks and work at high points will improve the alignment





can be avoided by having the boards equal in thickness and by joining the sap sides together with the grain running parallel. It is a mistaken notion that two pieces glued with the grain at right angles will remain flat, for each board swells or shrinks across the grain and causes twisting.

Sometimes table tops of $\frac{3}{4}$ " stock are thickened at the edges to give them an appearance of more massiveness. Strips may be used under the side edges, but for the ends cut pieces across the grain of a board, as shown in a drawing.

Where pieces are glued to the sides of a column, as in post-blocking a turning square to provide material for a bulbous enlargement, glue quartered stock to the vertical-grained sides and plain-sawed to the others to equalize shrinking.

What clamps are suitable? For edge-to-edge gluing, bar clamps are most

convenient. Those consisting of screw heads and sliding lower jaws mounted on pipes or wooden bars can be used on very long bars or on spliced units to reach almost any distance. Hand screws are useful for face-to-face gluing, exerting pressure over a wide area, and they can be adjusted to fit angles and odd shapes. For small work and for applying pressure in deep pockets or narrow places, C-clamps are available in many sizes.

Clamps for special work can be improvised. To assemble circular work or staved columns, use a chain and bolt every 6" or 8".

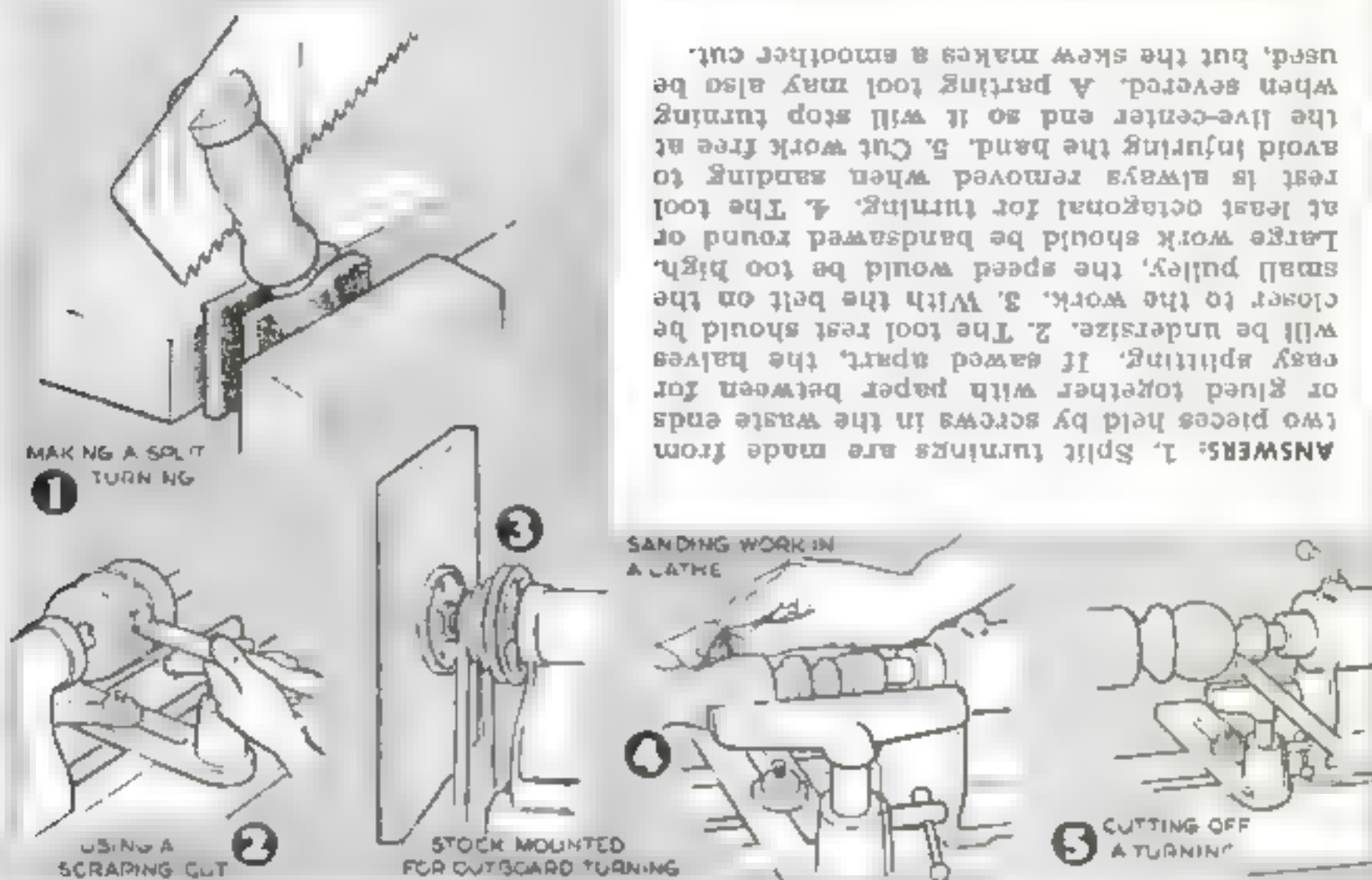
WOODEN PADS cut out to fit the jaws of the clamps will protect the edges of the work from being marred when pressure is applied



What's Wrong?

SIX wood-turning errors are shown in these drawings—two of them are in Fig. 3. The correct answers are printed upside down.

ANSWERS: 1. Split turnings are made from two pieces held by screws in the waste ends or glued together with paper between for easy splitting. It sawed apart, the halves will be undersize. 2. The tool rest should be closer to the work. 3. With the belt on the small pulley, the speed would be too high. Large work should be bandsawed round or at least octagonal for turning. 4. The tool rest is always removed when sanding to avoid injuring the hand. 5. Cut work free at the live-center end so it will stop turning when severed. A parting tool may also be used, but the skew makes a smoother cut.

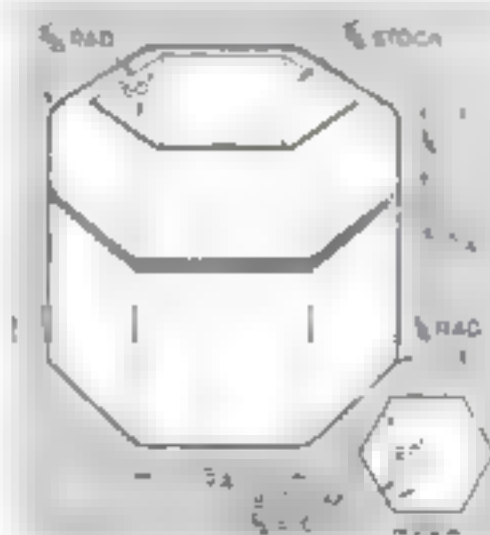


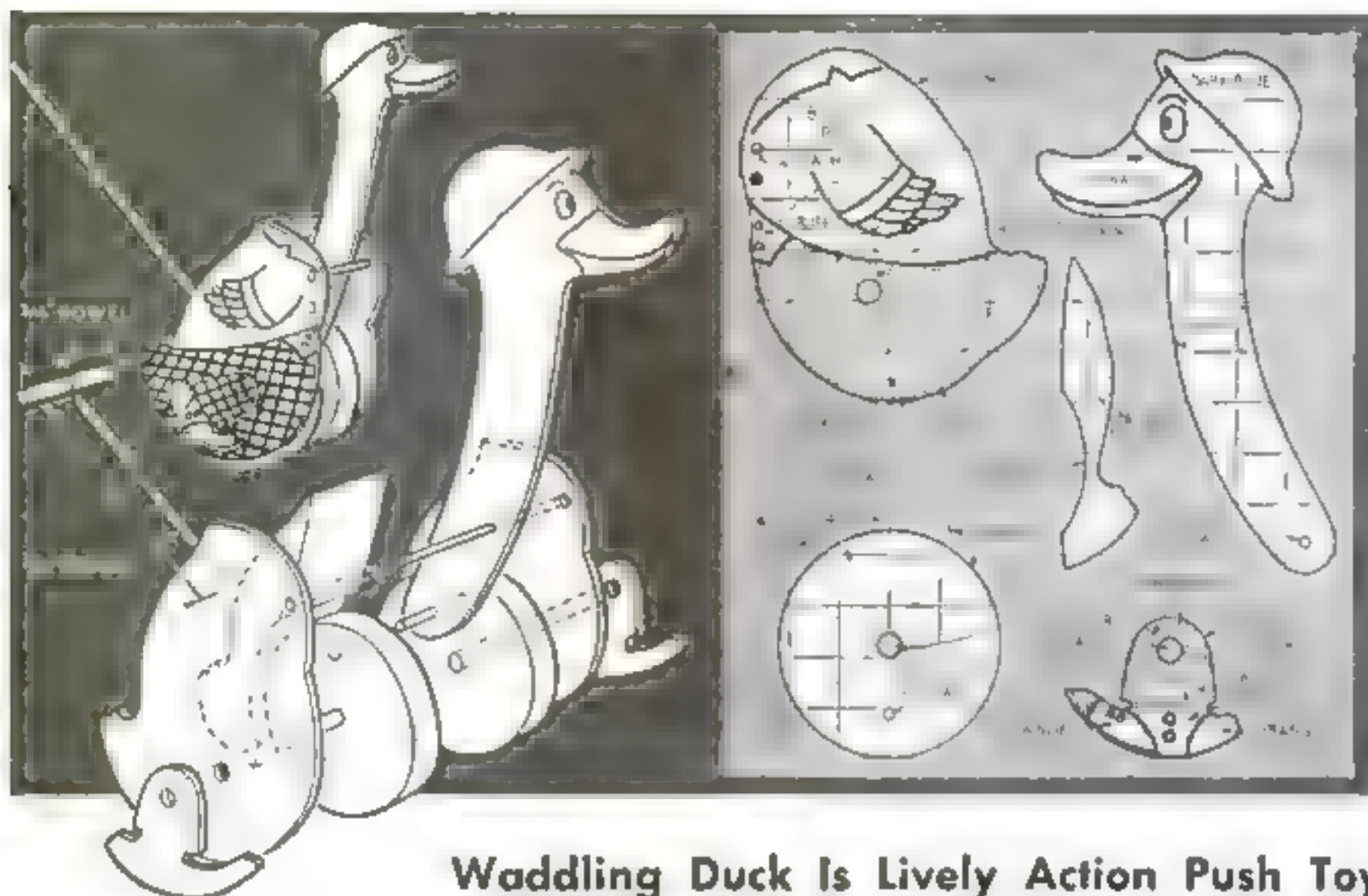
Modern Hexagonal Jardiniere Glued Up from Strips of Wood

THIS jardiniere with its straight, modern lines has the appearance of pottery when finished with brushing lacquer left in full gloss, but in reality it is a wood-working project. Beige for the base, and a strip of blue, green, or brown put on with masking tape, will make an interesting color combination.

Rip and joint one 33" length of stock and cut all the sides from it, allowing $\frac{1}{8}$ " extra length for each. Clamp them together along with the base for a trial fit, using a chain and blocks as shown in a photo on page 153, and check the joints for accurate fit. If the fit is not exact, take one thin shaving from each edge with a power jointer, if one is available, after adjusting the fence for the correction. A plane may be used for this if it is handled carefully.

After clamping for final gluing, tap the sides lightly to align the corners. The top and bottom ends should be worked straight and the corners and top edge rounded after the glue has hardened sufficiently.—E. M. L.



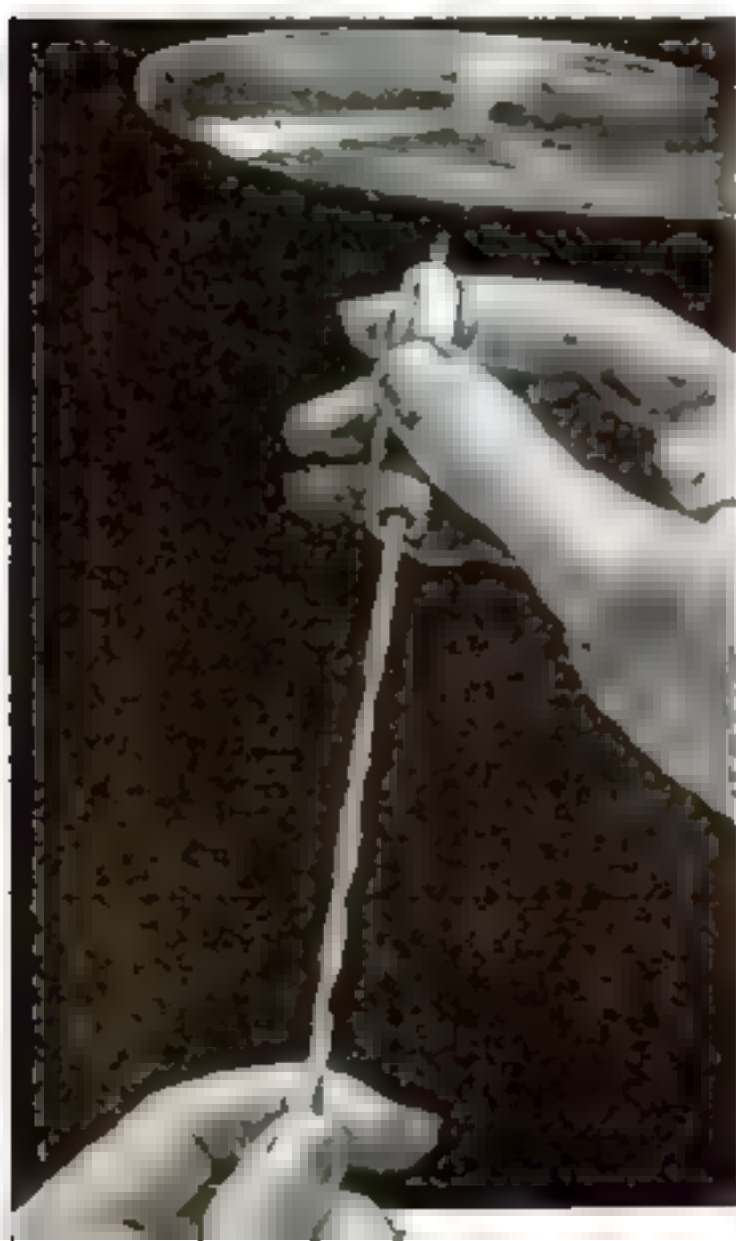


Waddling Duck Is Lively Action Push Toy

ANY child can put Mr. Duck through his paces. The pert-looking, waddling bird obligingly bobs his head up and down as he is pushed along the floor and does some very fancy stepping as he quickly lifts up and sets down his feet. And despite his awkward gait, Mr. Duck is easy to construct and has no parts that can get out of order.

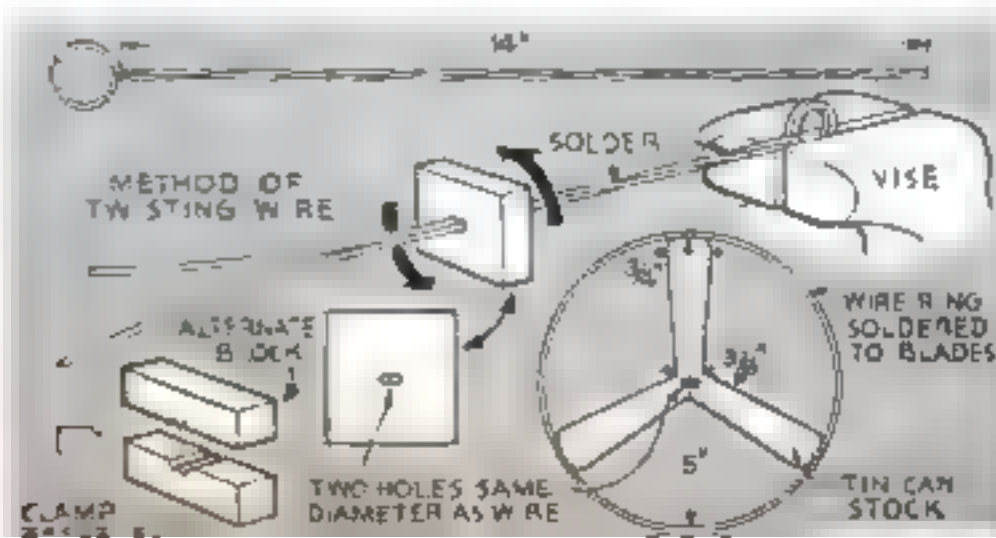
Scrap pieces of any thin wood or plywood, or even boards from an old orange crate, can be used for the sides, legs, and head

and neck. The wheels and the spreader are made from heavier stock—the ends of the orange crate may do in a pinch. Dowel axles, glued firmly into each leg and corresponding wheel, turn in holes in the sides; a third dowel, fitting loosely through the neck, is glued into both wheels; a fourth, joining the two sides in front of the neck, keeps the head from falling too far forward; and two dowels form the push rod. Paint in bright colors.—ELMA WALTNER.



Simple Helicopter Is High Flier

HERE is an old favorite that still brings thrills to an air-minded generation. The helicopter is cut from an unsalvageable tin can. Twist the blades slightly, and then solder a wire ring on the ends as a guard. A 32" piece of hay wire or any heavy-gauge wire is bent in the middle and twisted with the aid of a block as indicated below to make the rod. Start close to the vise and apply solder as the twisting proceeds; then cut the end of the rod in the middle of a twist. A package handle, a discarded hair curler, or similar tubing is used to push the helicopter off.

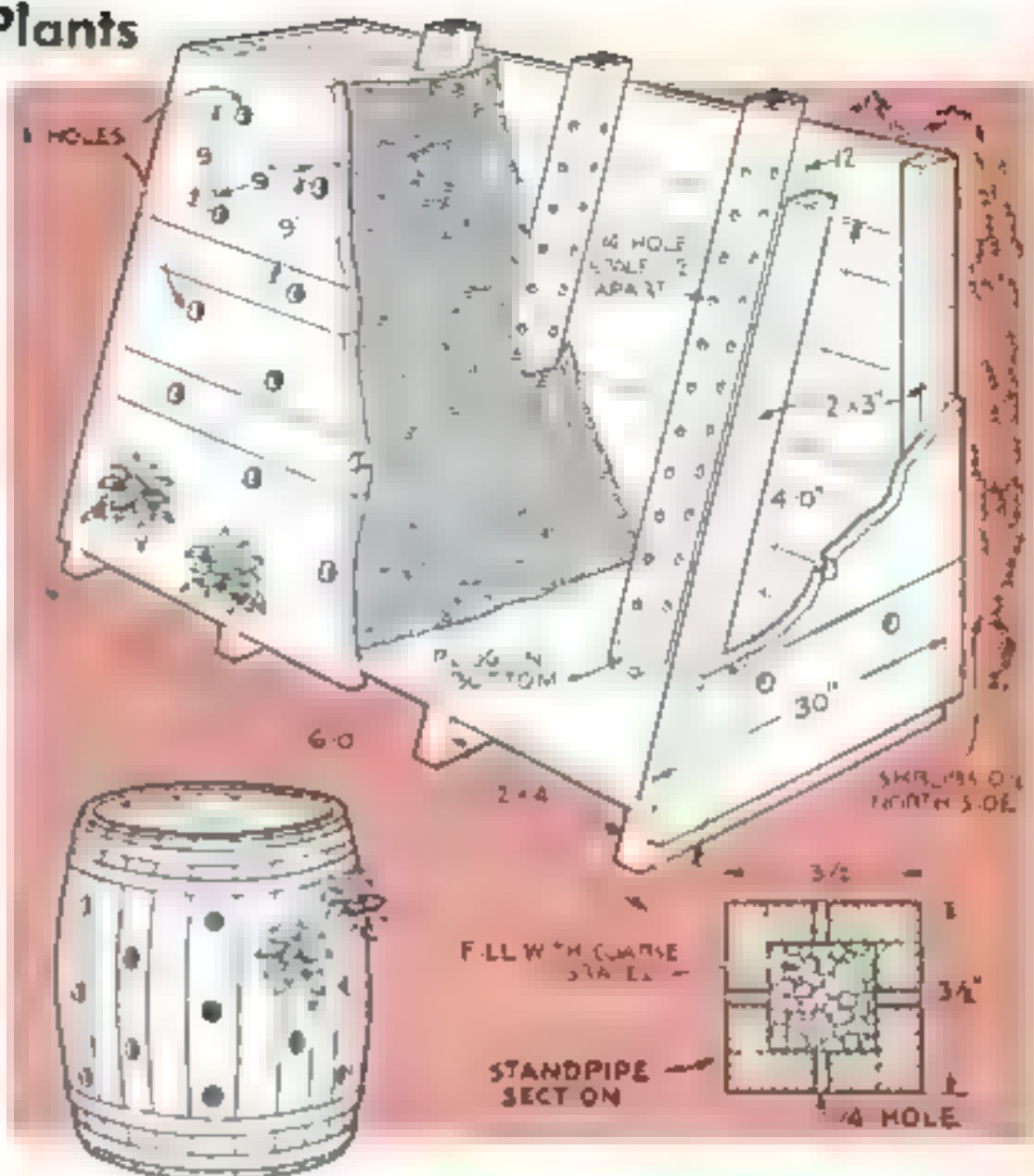


Strawberry Wall Holds 48 Plants

SET up in a sunny corner of a back yard, this strawberry wall will prove a decorative asset as well as a productive one. The red and green of berries and leaves, mingled against a background of weathered boards, make an exceptionally pleasing combination. Four dozen plants can be accommodated on the wall, where they will probably grow better than in the strawberry barrel often used.

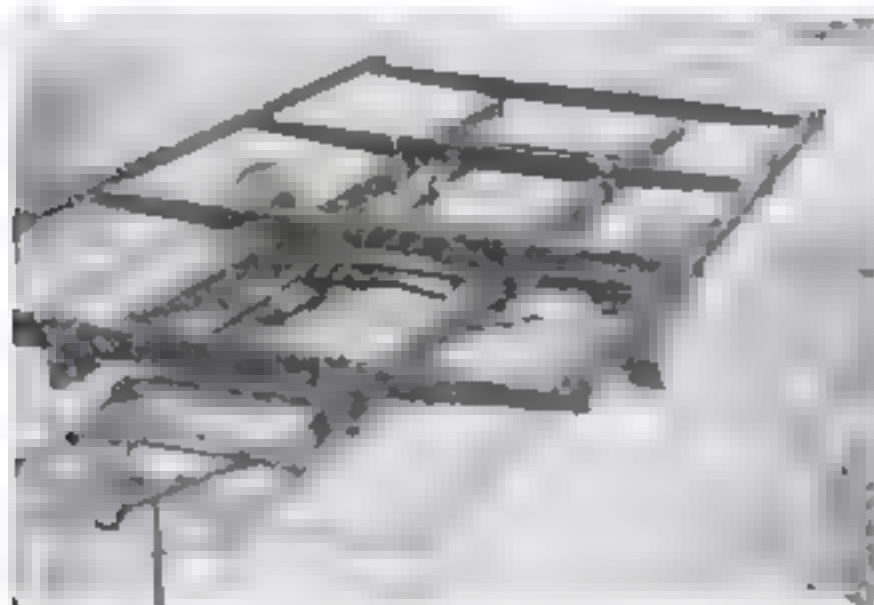
All holes for the plants should be spaced 9" apart. Even spacing is best achieved by installing the front boards temporarily and boring them and the ends. Then all front boards except the bottom one are removed and replaced one by one as the box is filled in stages with soil and the roots are planted a row at a time.

Any good garden soil may be used—preferably soil that has been well fertilized with manure and on which some other kind of crop was grown the year before. If manure is mixed with the soil just before using, it should be completely rotted. A little sand should be placed around the roots of each plant, and berries can be grown on top of the box as well as on the wall.



Coarse gravel in the irrigation standpipes will retard the flow of water and assist in its distribution to all parts of the box, insuring even the lowest plants of their share.

Capacious Farm Trailer Is Built of Old Auto Frame and Wheels



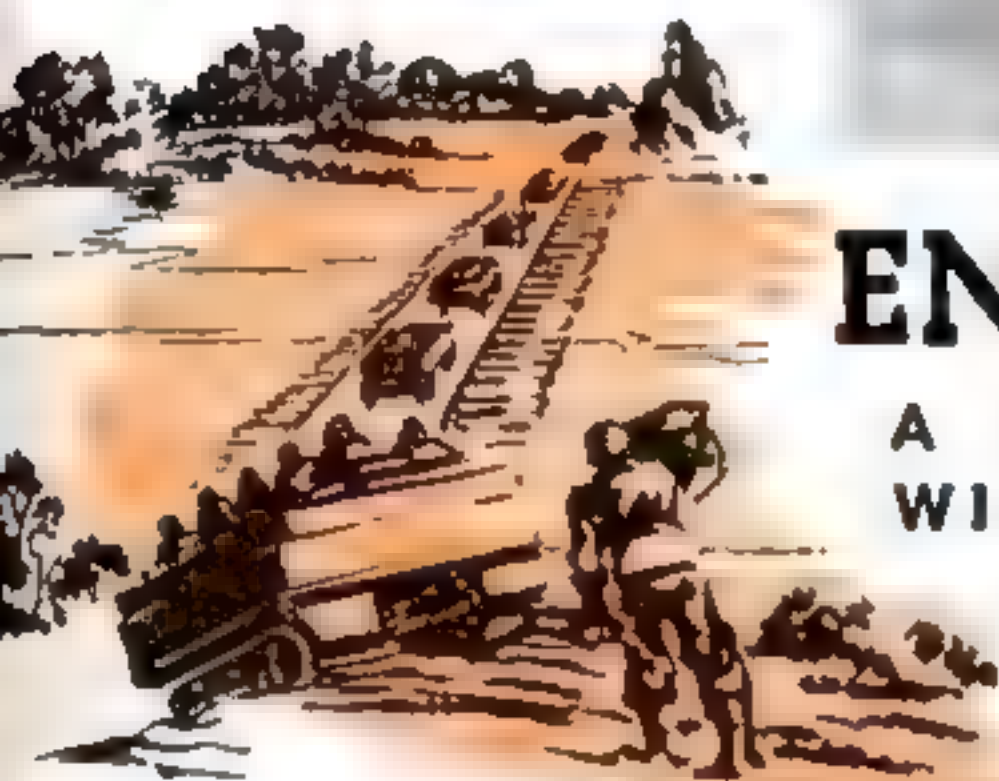
CONSTRUCTED principally of the castoff chassis and front wheels of an automobile, this two-wheeled trailer for a farm tractor can be used for many purposes in the field, including the hauling of large loads of hay. Because of the extra width between wheels and the absence of springs, the trailer is unusually stable on a steep hillside, and its design makes it easy to back up.

An I-beam 5' long was welded crosswise to the frame somewhat back of center, and to this beam were welded the front-wheel spindles of the car. At the front of the frame a common trailer hitch was attached.

A 14' long rack was constructed of wood, with a bed of two longitudinal two by fours spaced to get the full support of the chassis. Lighter stock was used for the remainder of the rack.—RALPH S. WILKES.

Made from the front wheels and chassis of an old car, this trailer becomes a useful farm accessory

Widened by the use of a 5' I-beam instead of the axle, it takes a big rack, as in the lower photo



ENGINEERS . . .

A NEW MARBLE GAME WITH A MILITARY THEME

By FRANK SHORE

HERE is a brand-new game made almost completely of cardboard. It calls for skill and good judgment and offers an interesting military problem. The object is to set up and man three gun emplacements on the other side of a river. It's a job for the Army Engineers! They must bridge the river first, and then set up the pillboxes for the advancing troops.

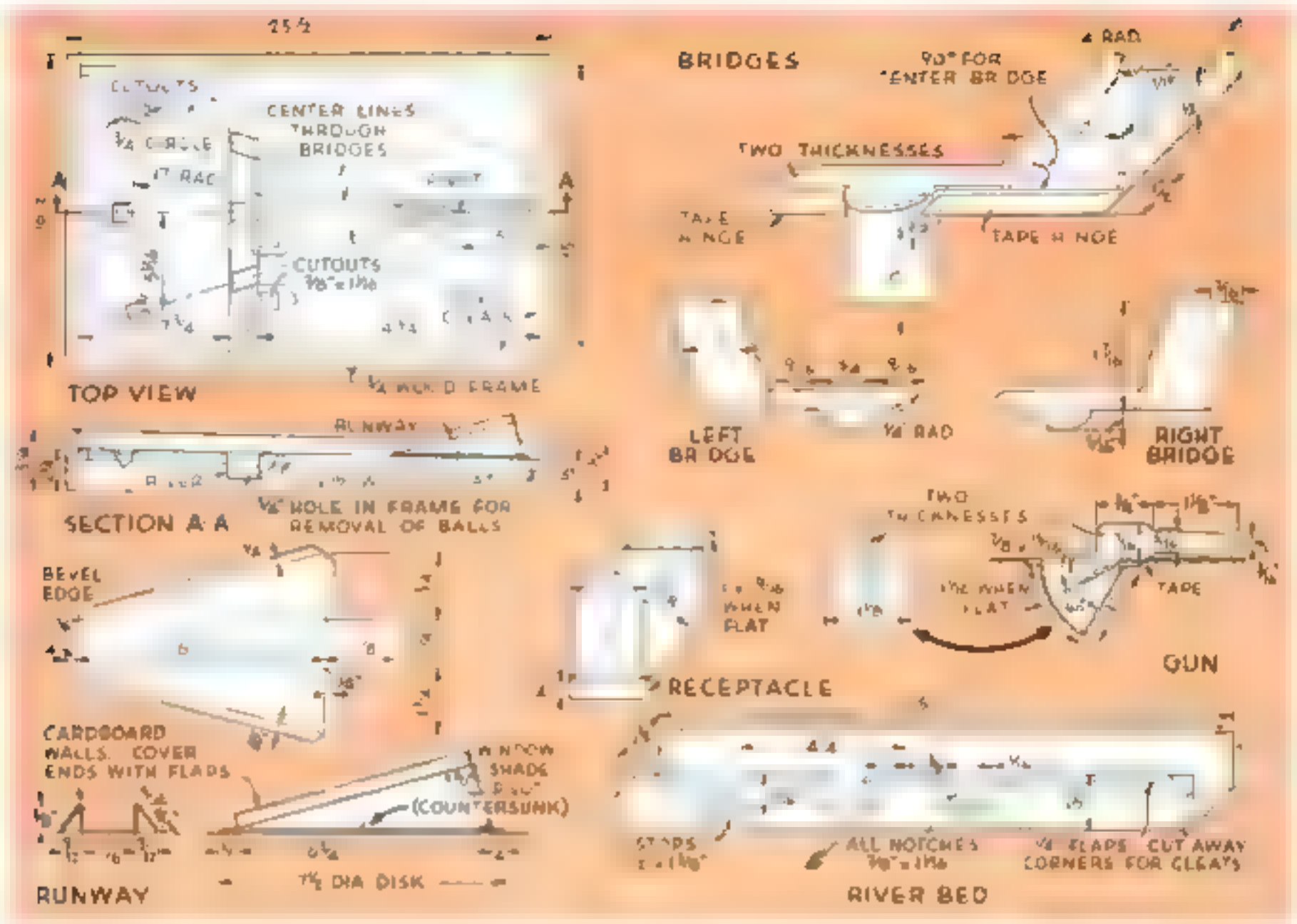
The game is played with marbles or glass balls $\frac{3}{8}$ " in diameter. They are started on a pivoted runway and must be shot first into the holes beside the bridges in order to make them rise so more marbles can be run across the bridges to raise the guns in the pillboxes. Two marbles are required to lift each bridge and anchor it firmly enough for others to be shot across without falling into the river. Speed is controlled by the height at which a marble is started on the runway.

The object is to man all three guns with the least number of shots. Nine is a perfect score.

A 15" by 24" piece of 14-ply show-card board is laid out, as shown in the drawing, for the playing board or top. Mark off the point at which the runway pivots, the edges of the river and the adjacent notches, and the slots and circles for the pillboxes. Note that the back of the pillbox squares are at the end of a 17" radius from the pivot point. Cut out the river, notches, and three squares using a sharp knife and a ruler, preferably one with a metal edge.

Build a frame of $\frac{3}{4}$ " wood, butting the corner joints, and glue and brad on $\frac{1}{2}$ " by $\frac{1}{2}$ " wooden cleats to which the playing board will be attached. It will be seen in the drawing that both the top edge of the frame and the playing board are at a slope.

Make the three bridges next, noting that only the center one goes across the river at right angles. This is because the center line of each bridge must follow the radius line to the corresponding pillbox so that the marbles can be made to travel across it accurately.



The vertical section of the bridge (shown in the drawing of the center bridge) should be attached after the river bed is in place on the board. It must be adjusted so that the far end of the bridge rises about $1/32$ " above the level of the board when two marbles are in the receptacle. When the receptacle is empty, the vertical section should be slightly below the level of the board. If it is too high, glue narrow strips of cardboard under the far end of the bridge. They will act as a bumper against the side of the river bed and keep the vertical piece from rising too high.

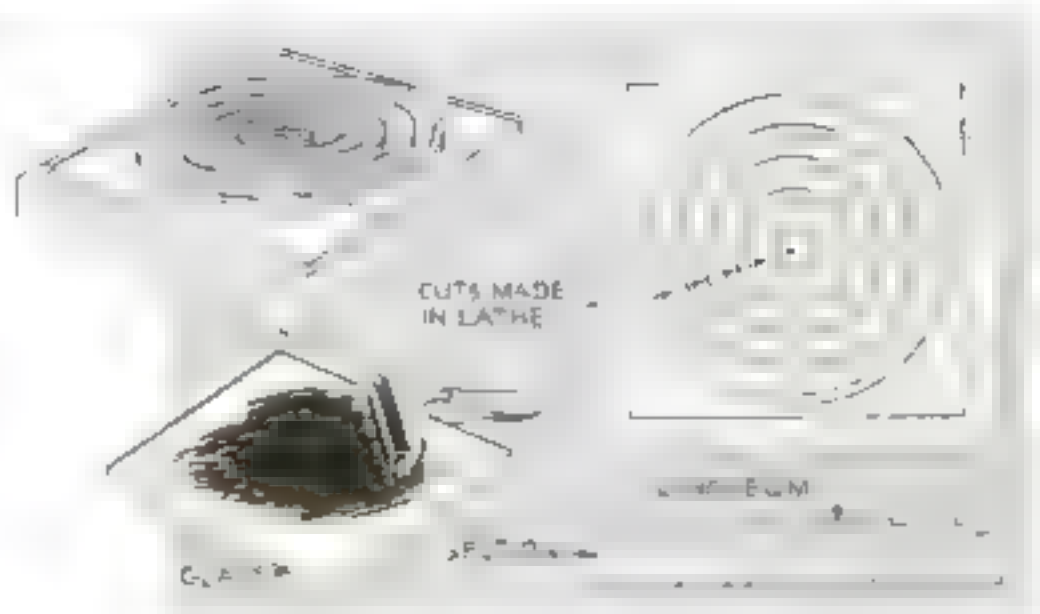
Cut out and fold the river bed as shown in the drawing, and then glue it in place with its sides at right angles to the board. Next, the receptacles for the marbles that raise the bridges are attached with glue.

The guns are cut out and mounted on rectangles that are attached with cloth tape and glue, and the marble receptacles operating them are then put in place. Be sure to center the back of the squares of the pill-boxes at the end of the 17 " radiuses from the pivot and at right angles to them.

Cut out the runway and fold it as shown, gluing the flaps to a cardboard disk $7\frac{1}{2}$ " in diameter into which a pivot of the types used on window-shade rollers has been inserted. This pivot is then mounted on the playing board and glued to it. Countersink it slightly into both the runway disk and the playing board to give it a firm setting. Both the lower end of the runway and the front part of the disk should be beveled in order to smooth the path of the marbles.

Block for Printing Targets Made of Linoleum Cut in Lathe

MOUNTED on wood and chucked in the lathe, a piece of linoleum can be cut quickly and accurately for a printing block to make targets for rifle and BB-gun practice. Apply printers' ink or black oil paint by rolling it on a sheet of glass with a rubber roller and transferring it from the roller to the linoleum. BB shot can be recovered if a target is mounted on the side of a corrugated cardboard box.—RICHARD SALZER.



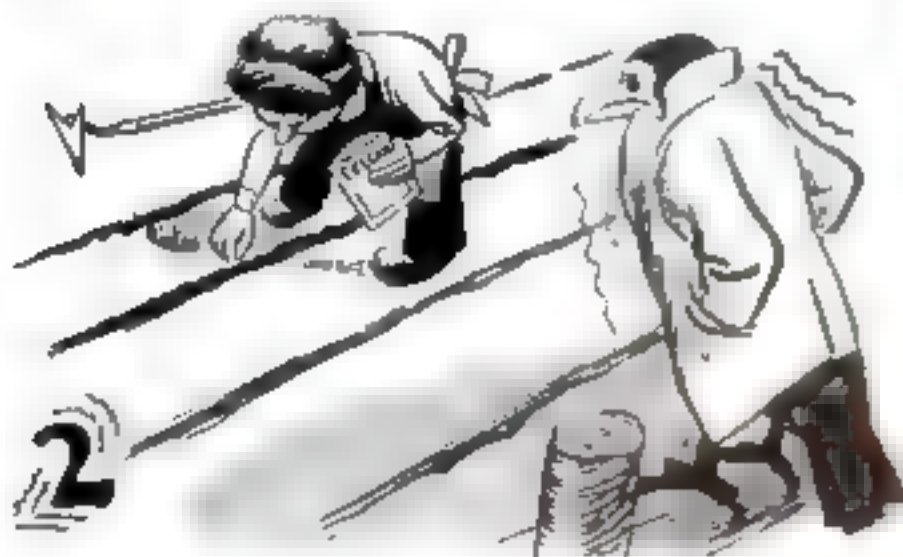
TEN MISTAKES OF

By HAYDN S. PEARSON

UNCLE SAM is asking for a 25-percent increase this year over last summer's Victory gardens because of the vast food requirements of fighting men and civilians. Whether your garden is a success depends on many factors. Here are 10 common beginners' mistakes. If you avoid them, your total food production will be increased—and that's the Victory-garden goal.



TOO LARGE A GARDEN. A small plot, prepared and cared for properly, will out-yield a much larger one that isn't handled well. If land is scarce, don't plant corn or potatoes. Squashes, cucumbers, and melons can be put in hills at the edge and the vines trained to run outside. Beans raised on poles 2' apart and tomatoes on stakes 18" apart will save considerable space.



PLANTING TOO EARLY. If you put your seeds in when the ground was still wet and too cold, they may have come up all right, but don't expect them to grow and produce as they should. Look around your neighborhood and get acquainted with the most experienced gardeners, find what schedule they followed in planting, and adopt their timetable. Seed dealers can also give you good advice for your locality.

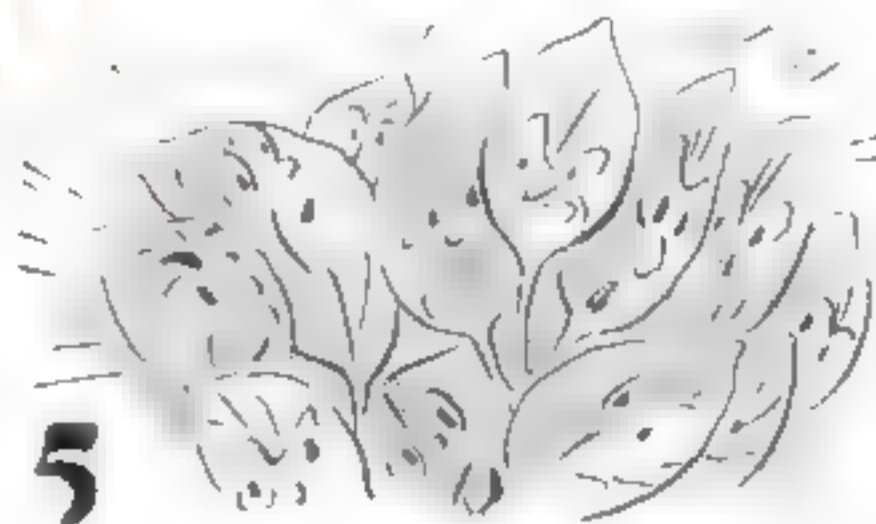


INADEQUATE SOIL PREPARATION. A good seed bed, deep and mellow, is two thirds the battle in raising good crops. Don't take too seriously, unless you are an expert and know what you are doing, current fads about not plowing or stirring the soil. Don't make your plants compete with clumps of turf, stones, and perennial-weed roots.



LACK OF FOOD. Before planting, rake into the soil a general fertilizer (4-8-8, 5-8-7, or 6-6-6) at the rate of 8 lb. per 100 sq. ft.; then, as the plants grow, spread a little more between rows. Dried manure, 4 lb. per 100 sq. ft., is also good.

PLANTING TOO CLOSE. Crowding robs plants of vitality. Follow directions on the seed growers' packets. It takes courage to thin out and throw away plants—but this will vastly increase your yield.



AMATEUR GARDENERS

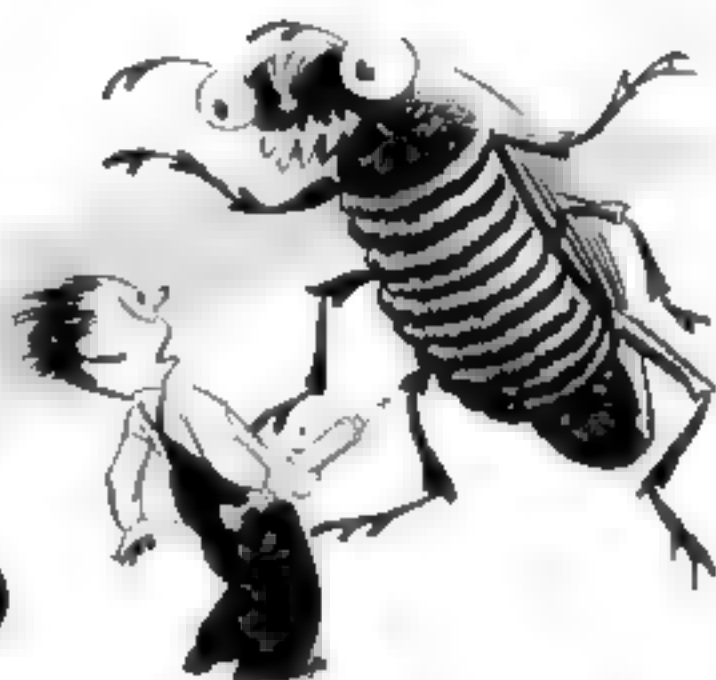


6 LACK OF CULTIVATION. Soil should always be kept soft, friable, and free of weeds. A good rule is to cultivate after every rain. This breaks the crust of the earth. Every gardener should have some kind of hand cultivator. With it he can do most of the required work and reduce considerably the amount of hoeing necessary.



7 PAT-A-CAKE WATERING. It's fun to play with the hose and sprinkle water around; but unless you give the soil a thorough soaking, watering does more harm than good. Light watering doesn't penetrate and simply keeps plant roots near the surface.

NONSUCCESSION OF CROPS. Beets, carrots, lettuce, string beans, and the like planted over a long period mean food over a long period. When early crops stop producing, put late types in the same ground.



9 GIVING PESTS A START. Probably the most discouraging thing that can happen to an amateur gardener is to watch midsummer insect pests devour the crops he expected to have on his table, yet this can be prevented if he is forehanded and does his spraying and dusting on time. You can get the very best information on combating plant hazards in your section of the country by sending to your State college for the latest bulletins on controlling insects and fungi; follow them scrupulously.



10 CHEAP SEEDS AND TOOLS. This year more than ever, you should beware of bargains. If seeds and tools are offered cheap, there is a reason: the former probably will be low or weak in germination; the latter poorly designed and badly constructed. Good seeds are the foundation of successful gardening. Good tools will do good work and, with good care, will rarely have to be replaced. Don't start off with a handicap.



Good Riddance to RHUS TOXICODENDRON (POISON IVY TO YOU)

**Chemical Warfare Against Plant Nuisance
Number One Is Usually the Best Means of
Eliminating This Pest Around Your Home**

POISON ivy may be the most unpopular of the weeds, but it certainly gets around! Its notorious three-leaf clusters menace picnicker and casual passer-by almost everywhere in the country. Its bark and pollen are nonirritant, but the poisonous element—an oily, nonvolatile substance called urushiol—flows in the sap and pervades all parts of the plant. Urushiol can even be carried by soot and smoke when the plant is burned, and it lingers as a hazard in winter when the roots and leaves appear to be dry. The insidious oil will even cling to soil particles, so when digging in an area where poison ivy once prospered, don't let it catch you barehanded.

This villain of the woods and fields grows as a small shrub, or else climbs in vinelike fashion along tree trunks, stone walls, and fences. Notches along the leaf margins indi-

cate poison oak rather than poison ivy, but it's still no less of a nuisance. Both forms have waxy white berries, resembling those on mistletoe. Poison sumac, an even more vicious relative, is fortunately rather uncommon and thrives chiefly in swamps.

If you actually touch poison ivy and don't suffer from it, you're pretty lucky. But indirect contamination often occurs, with shoes, clothes, and tools the guilty agents. You can even be infected by petting a cat or dog that has brushed against poison ivy. After a known exposure, you may get some protection by prompt washing with soap and water or by sponging the affected parts with alcohol. Before exposure, you may also achieve a measure of protection by applying olive oil to the hands and face. But don't count on it.

Physicians sometimes give inoculations to known poison-ivy "sensitives" in an effort to reduce the severity of poisoning, but the benefits are not certain. Medical researchers tend to believe that absolute immunity does not exist,

even though many persons are fairly insensitive. Anyone who has bravado enough deliberately to touch or even chew poison ivy—it has been done—should be warned that he's begging trouble. Instead of becoming immune, he may acquire such extreme sensitivity that the slightest contact in the future may bring on a severe infection.

Once acquired, a poison-ivy infection is best healed by time. Calamine lotion is sometimes used to relieve itching. Wet dressings of a boric-acid solution are sometimes prescribed. There's a chance of confusing the symptoms of ivy poisoning with those of other conditions, so that if there is any doubt, and when the inflammation is severe, a doctor should be called.

Arm yourself well when laying siege to poison ivy; heavy gloves and thick clothing are desirable. An ordinary iron rake is an



Poison Ivy



Poison Sumac



Poison Oak

effective weapon for grubbing out the tiny rootstocks, practically all of which must be destroyed if your campaign is based on physical rather than chemical elimination. Bits of roots that are not pulled out can be discouraged, if not killed, by sprinkling salt borax, or sodium chlorate on the ground.

Don't forget, when doffing clothing after a session of attacking poison ivy bodily, that all exposed surfaces can be considered contaminated. Clothes should be sent to the laundry, boots and tools swabbed off with soapy water. These measures may not be necessary if you're not especially sensitive to ivy poisoning. But they're good insurance anyway.

Sodium chlorate has until recently been a favorite chemical for destroying poison ivy. However, this solution has a tendency toward spontaneous combustion on drying, and its user must therefore be on guard. At present the best chemical solution for killing the plant appears to be ammonium sulphate,

Although it will grow like a small shrub if no support is near by, poison ivy readily climbs like a vine. Even when the leaves are gone, as at the extreme right, poisoning can take place

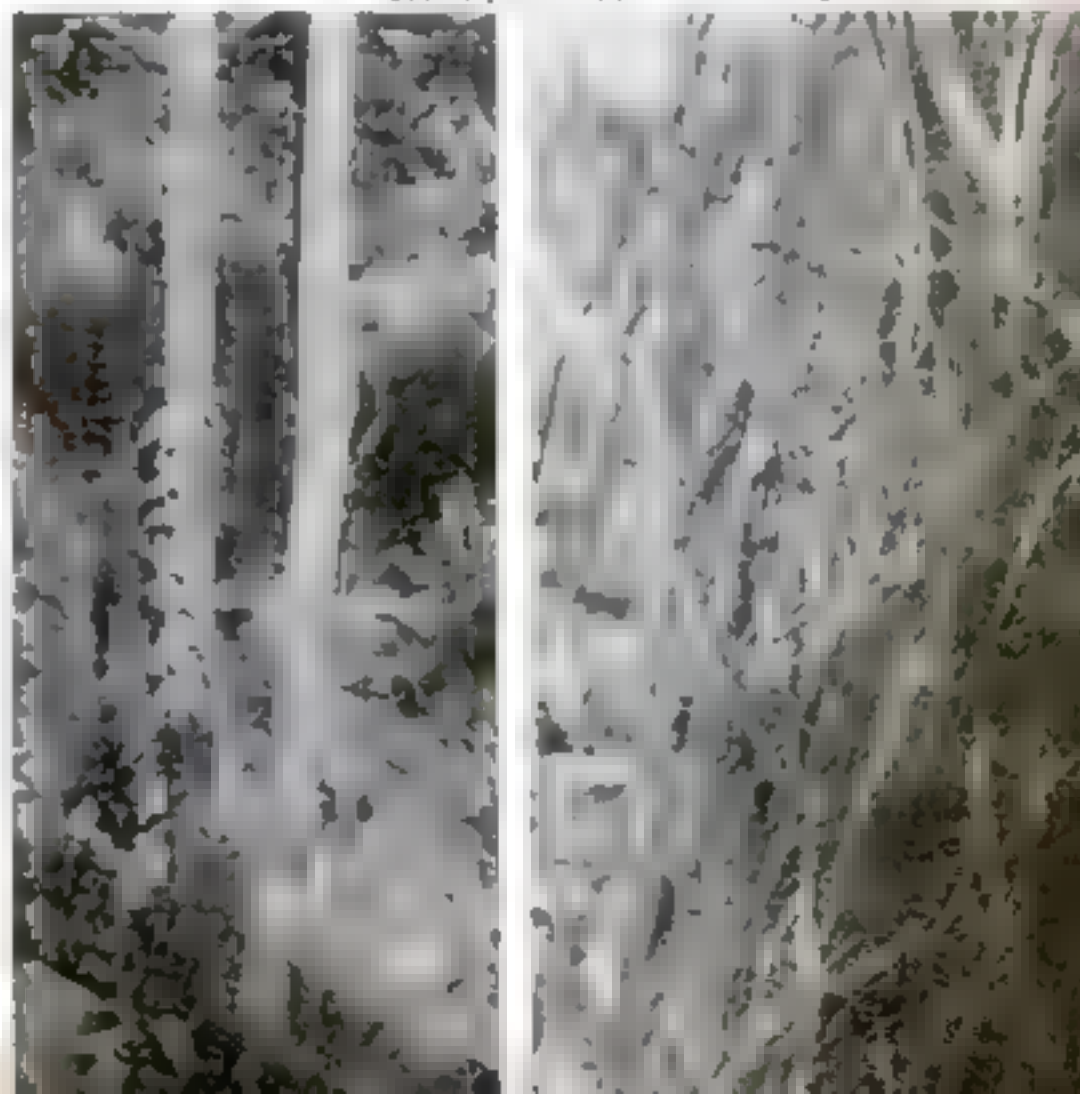


Courtesy E. I. du Pont de Nemours and Company.

Probably the best weapon for counterattacking ivy is ammonium sulphamate solution in a sprayer

mate, which is not hazardous to livestock, does not cause spontaneous combustion, and if properly applied, does not long sterilize the soil to which it is applied. In spraying it, the nozzle should be adjusted to give a fairly coarse spray, since fine mists might drift toward plants that it is desirable to protect from any injury.

Courtesy New York and Brooklyn Botanical Gard



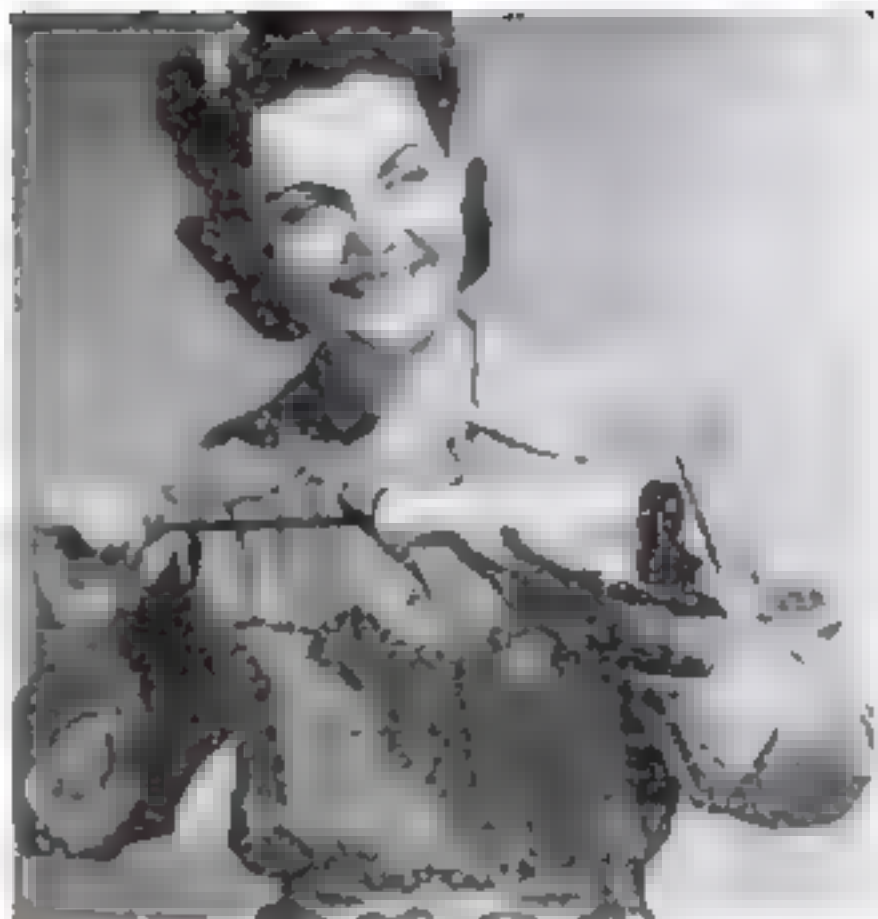
OF INTEREST TO HOME OWNERS

INSECT PESTS suffer heavy casualties when attacked with this new insect gun, which is fabricated solely of plastics, glass, leather, paper, and wood. Lighter and easier to manipulate than the former all-metal spray guns, the new device has a broad-based bottle that will not tip easily. It effects a great saving in tin, steel, and paint.

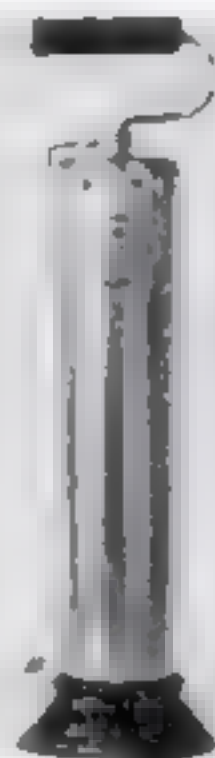


A CHEMICAL CHIMNEY SWEEP cuts down on heat loss resulting from soot accumulations in furnaces. Sprinkled directly on the fire, the chemical begins to burn and throw off nonpoisonous, nonexplosive gases. These form a white coating on soot that, according to the makers, destroys it within 36 hours. Three or four applications are said to suffice for the average furnace operating in a one-family home.

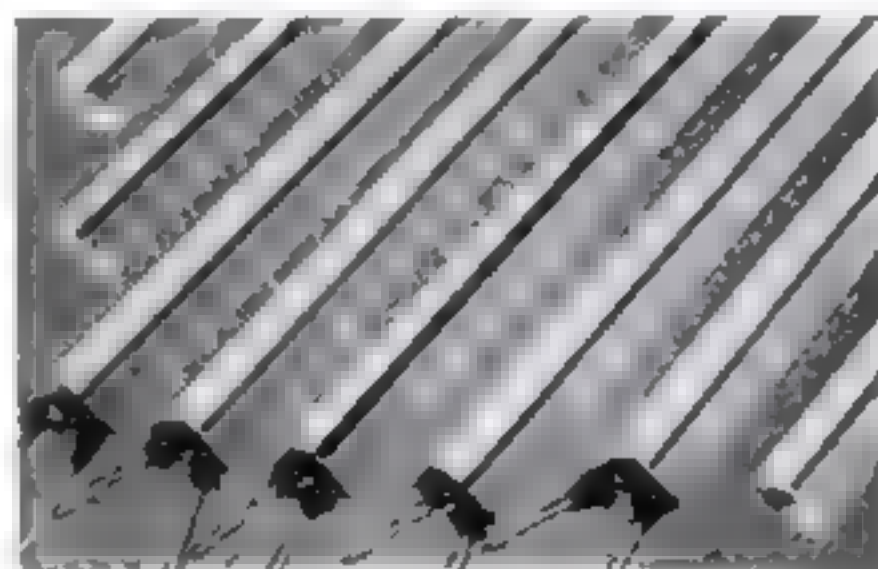
TO CALK CRACKS in masonry or seal other defects, an unusually elastic compound can now be used. It comes in tubes for small jobs, in gun cartridges for large ones. Although forming a hard surface when applied, the material remains pliable underneath and thus resists vibrations and other conditions that might crumble or loosen it.

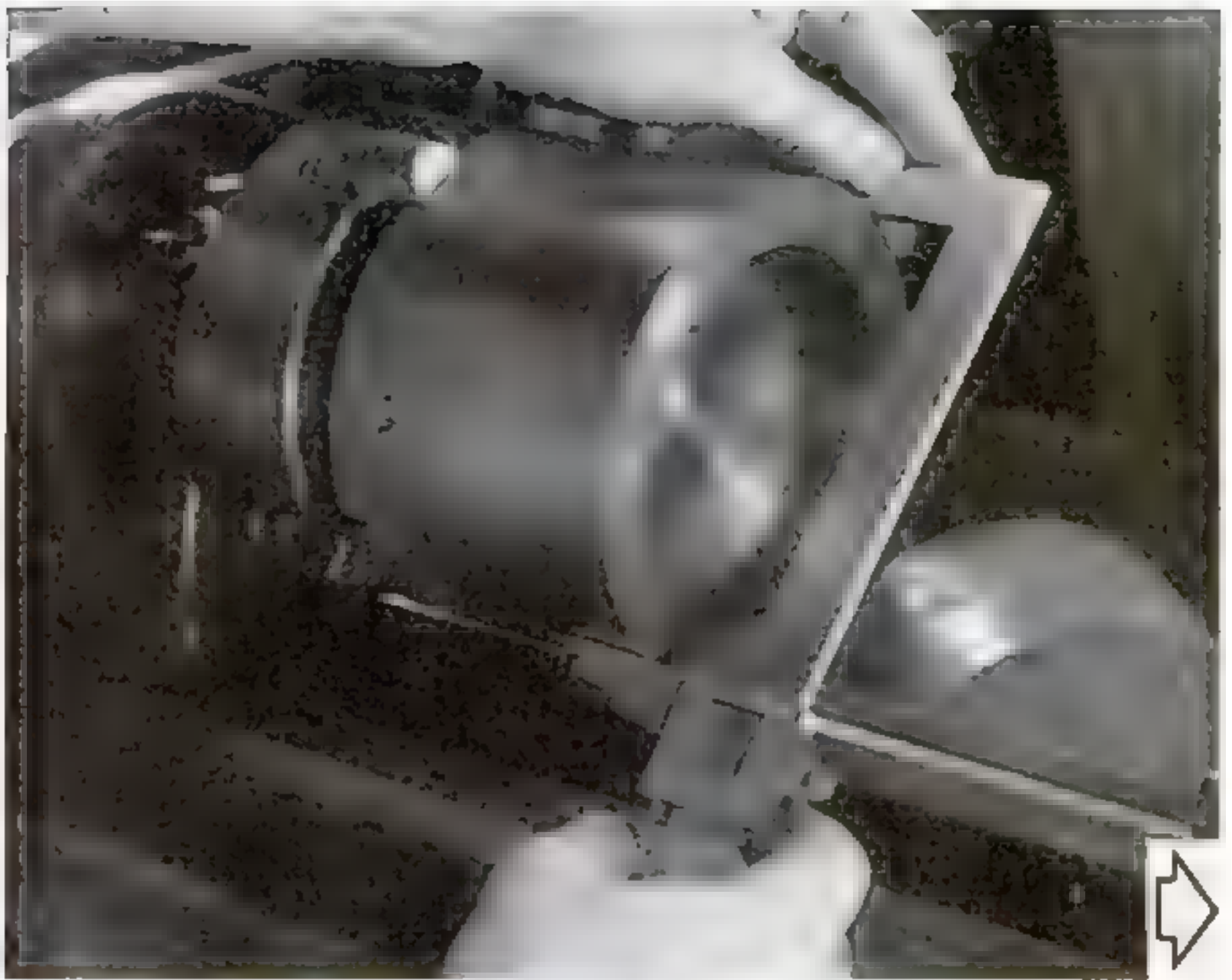


SUCTION SO STRONG that it will even aid in removing auto body dents is developed by the pump at right, designed for cleaning out clogged drains. Made of cadmium-plated steel, the pump consists of a double-acting piston and vacuum cap. It is placed over a drain, and quick movements of the plunger free any obstruction. When continuous suction is needed, its pressure can be held by turning a screw.



STRIPED INSULATION for electrical wiring makes it easier to identify circuits that are part of a complex network. The tubing, shown below, is made of a cellulose acetate plastic that resists electrochemical corrosion. During extrusion, the lines of color are made an integral part of the body and are as permanent as the tubing itself.





A "MUST" FOR THE SKILLED MACHINIST . . .

Reading Vernier Scales

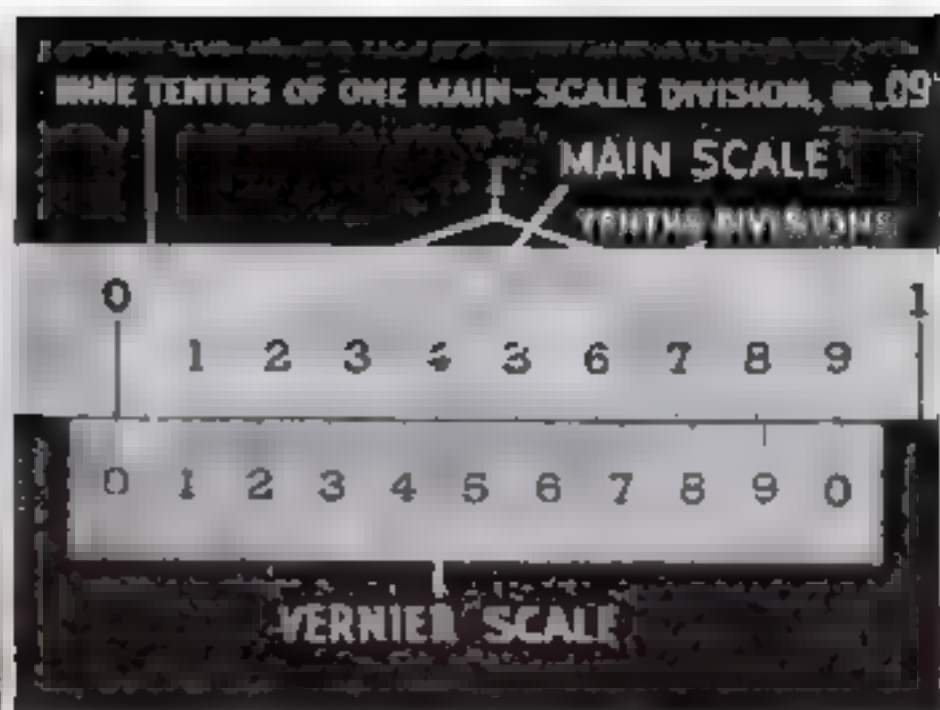
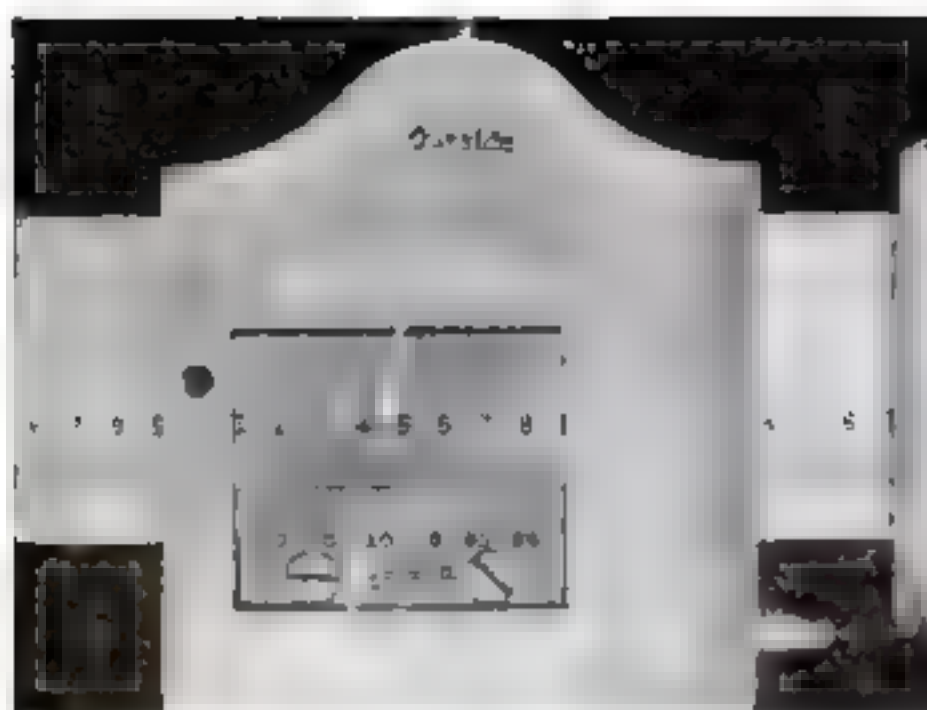
PRESENT-DAY mass-production methods requiring the speedy manufacture of interchangeable parts have put emphasis on the extremely accurate fixed gauge; but if you would be a master machinist, or hope to turn out precision work in a small shop or in your own basement, a knowledge of vernier scales is indispensable. A fixed gauge, preset for a machine operator engaged in the production of a single part, is foolproof and assures accuracy of .0001" and better; in the smaller plant where the machinist is called upon to make a variety of parts, adjustable measuring instruments—some of them also reading to .0001"—are often found more practical.

The most common of these adjustable instruments are vernier calipers and vernier height and depth gauges, all of which are graduated to .001", and the widely known micrometer—accurate to .0001"—which for generations has been the stand-by of every machinist worthy of his salt. All are prac-

tical applications of a simple and ingenious method invented more than 300 years ago for taking measurements in minute fractions by means of two sliding scales.

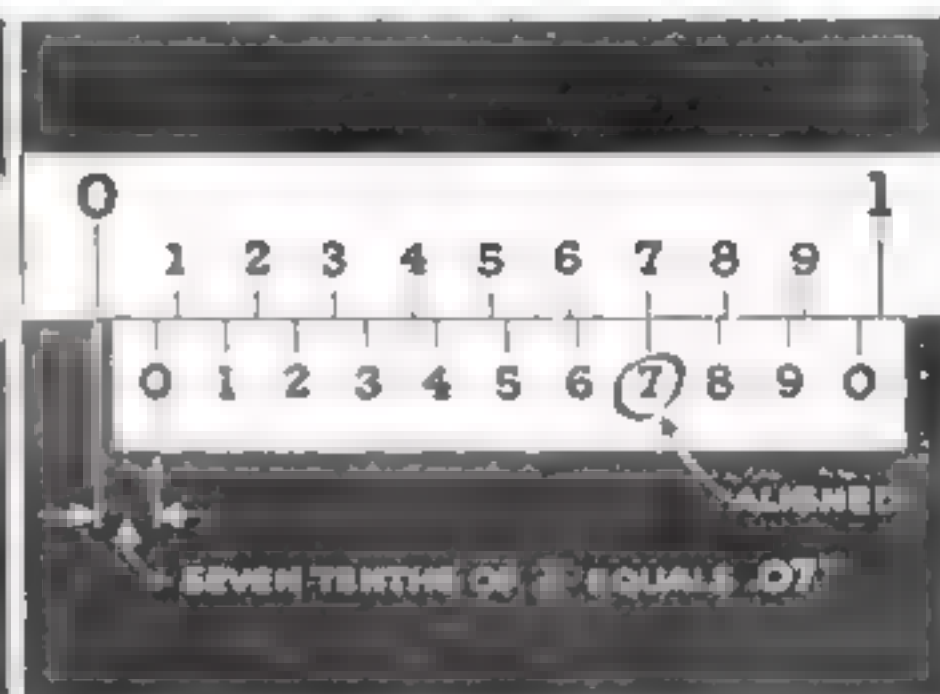
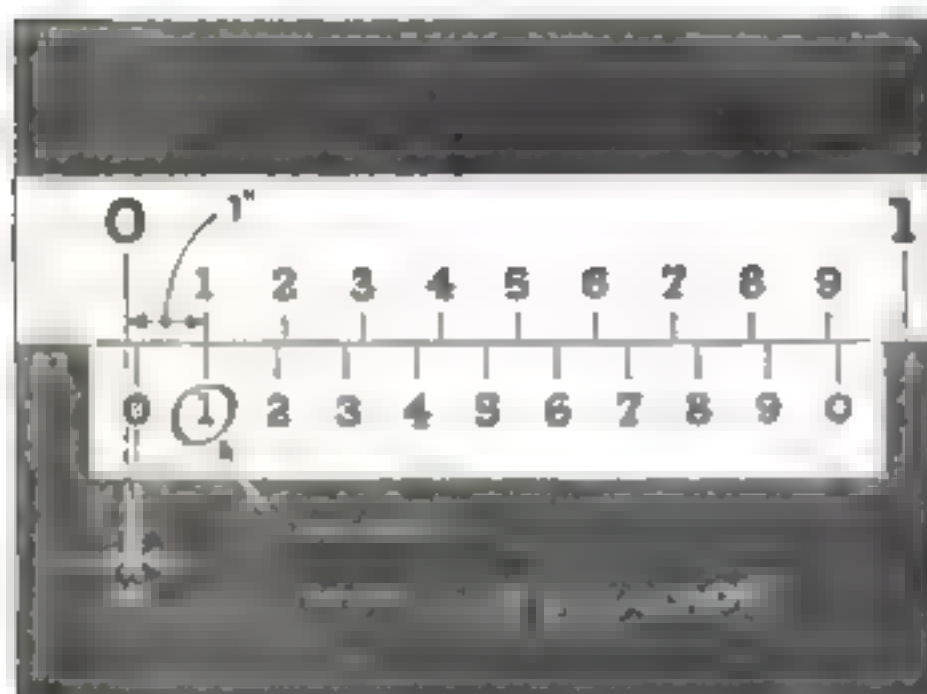
How easy it is to learn to read these vernier scales is shown graphically on the following pages. The illustrations are from a motion picture produced by the U. S. Office of Education and distributed by Castle Films as an aid in the wartime training of machine-tool operators.

In using fine-adjustment instruments of the micrometer and caliper type, there is but one more detail to master after the eye has been trained to read the vernier scale. Expert machinists always make the final adjustment on the screw of the gauge with a slight rubbing motion of the ball of the thumb and forefinger where the sense of touch is extremely acute. Development of this sense of touch or feel is merely a matter of practice, and when once it has been mastered it becomes almost second nature.



1 Vernier scales make possible precision reading of fractions between the smallest divisions of a main scale. The vernier scale shown here is on the moving part, the main scale on the fixed part

2 Both scales above have 10 divisions, but all 10 vernier divisions span only nine of those on the main scale. Each division of the vernier is therefore nine tenths of a main-scale division

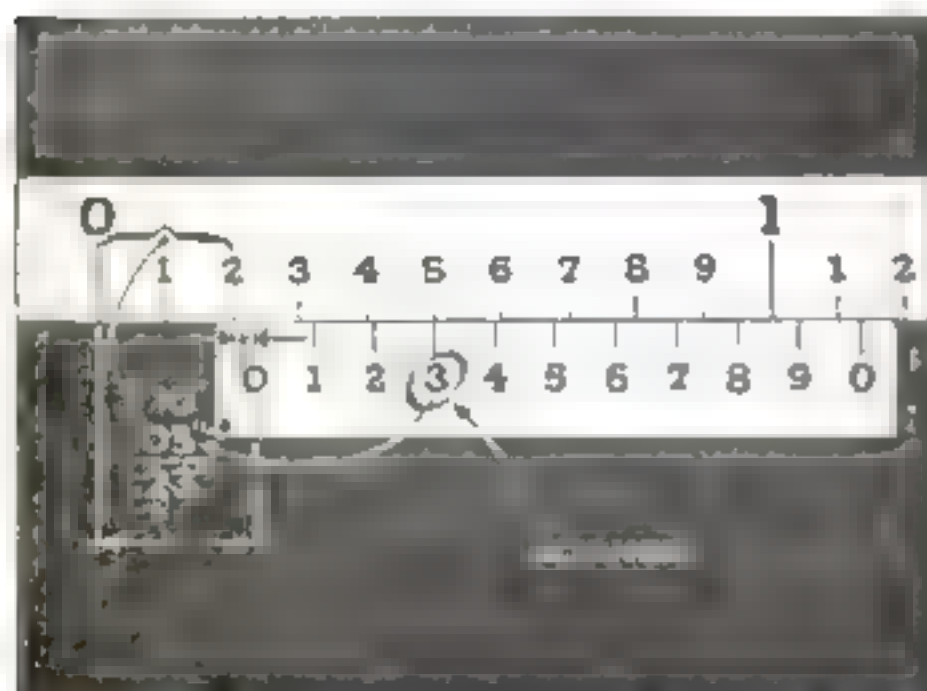


3 Let each main-scale division represent .1" and move the vernier over so that the first marks on both are aligned, as above. The vernier moves one tenth of a .1" division, or a distance of .01"

4 Now move the vernier so the two sevens will be aligned. This means that the vernier has been moved seven tenths of a .1" main-scale division, as shown by the two zeros, and the reading is .07"

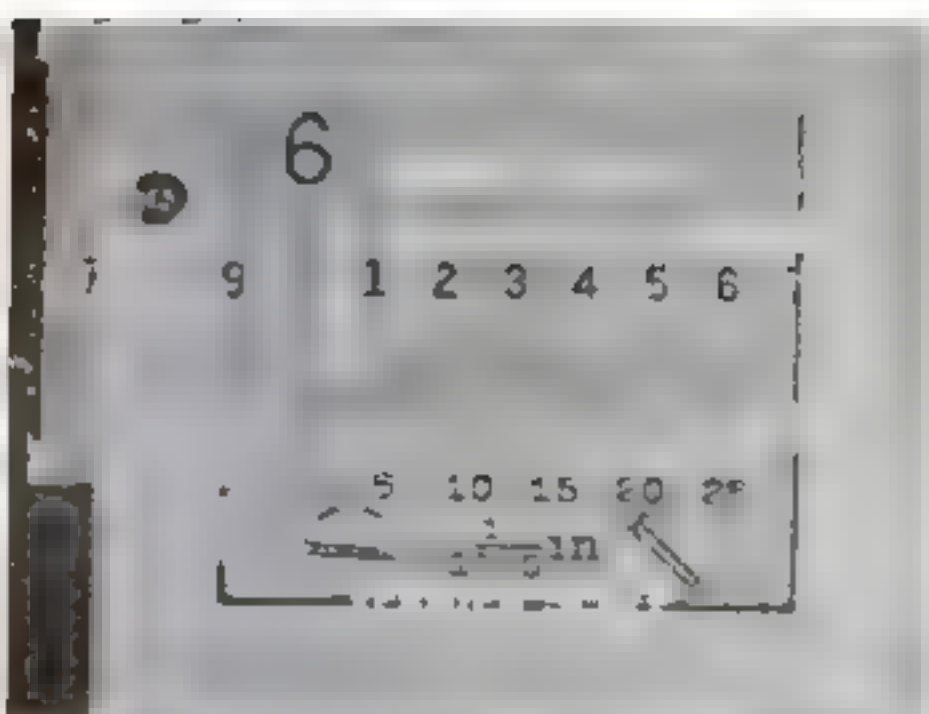
5 Readings begin with the main-scale division to the left of the vernier zero; then always read next the aligned vernier division, disregarding the number above it. Here .20" plus .03" equals .23"

6 Here the vernier has moved further on the main scale so, reading left of the vernier zero, we get 5.00" plus .30", and then—taking the aligned vernier mark—we add another .06" to obtain 5.36"

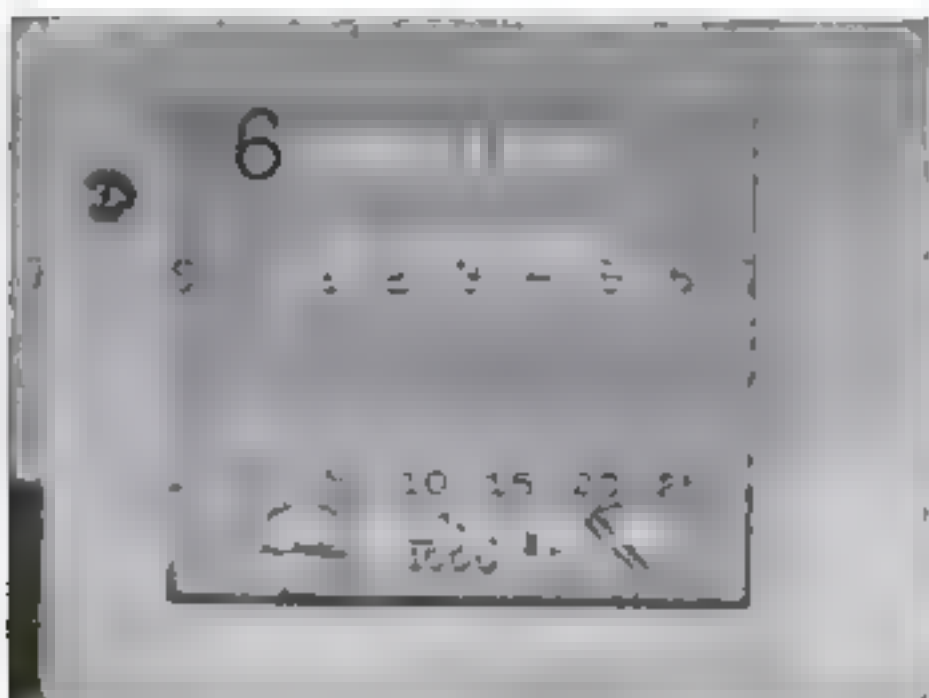




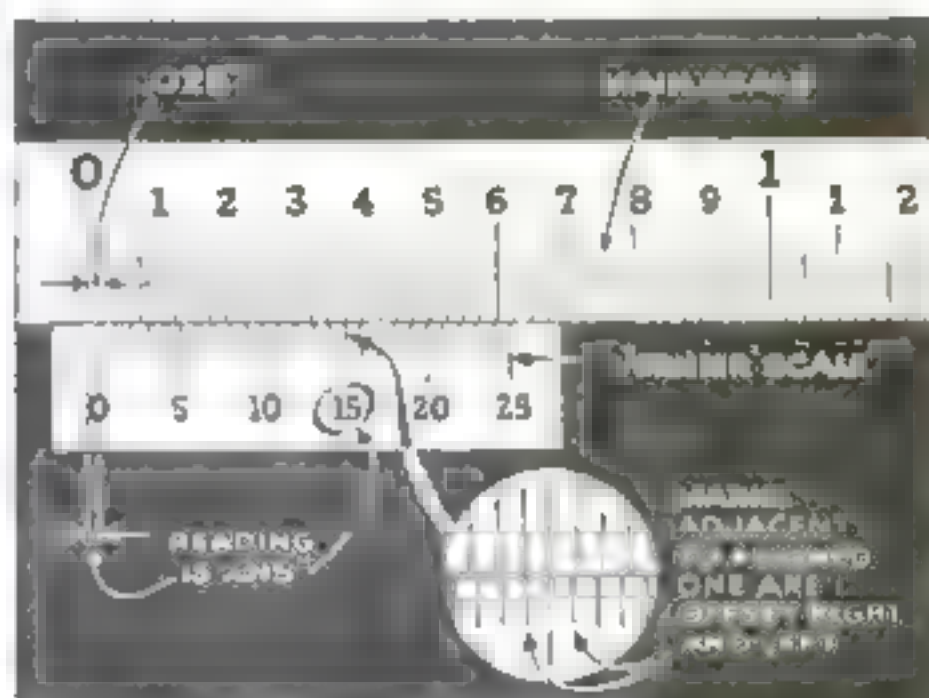
7 On vernier calipers (above) and height gauges, the sliding jaw containing the vernier is set approximately and setscrew A tightened; then final adjusting is done with screw B, and C is tightened



8 Each inch of a caliper or height-gauge main scale is divided into tenths, and each tenth is divided into fourths. Thus, one fourth of .1" equals .025". The vernier divides this further



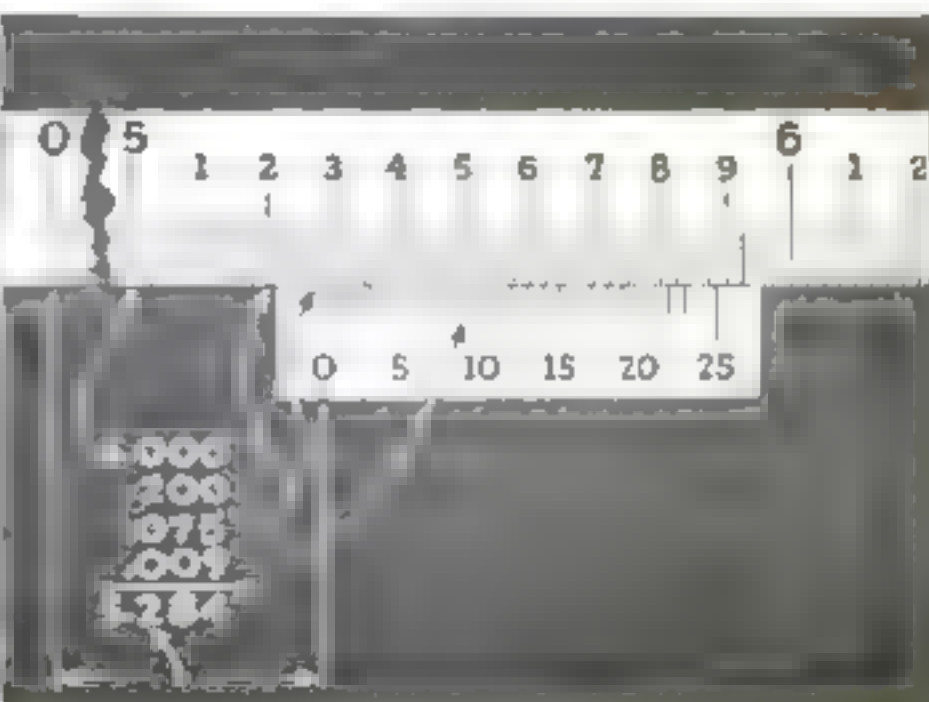
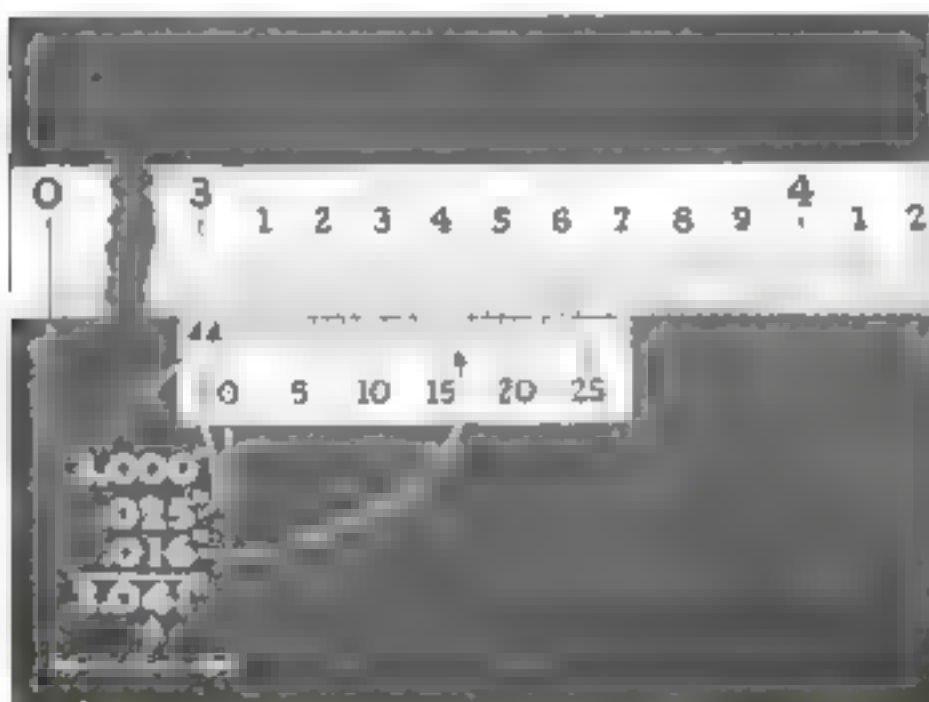
9 Note this vernier has 25 divisions instead of 10 and spans 24 on the main scale. Therefore it divides the smallest main-scale division into 25 parts, and one twenty-fifth of .025" equals .001"



10 Read the vernier at the mark aligned with a main-scale division, here 15, or .015". One simple trick in finding an aligned mark is to look for the two nearest marks offset right and left

11 As on a scale in tenths, read the main-scale division left of the vernier zero first, here 3.025", and add the aligned vernier mark, which is 16 in this instance and is read simply as .016"

12 In this example, the vernier nine is aligned, and represents nine twenty-fifths of a .025" division on the main scale, or .009". The reading is thus 5.275" plus .009", or 5.284" (Turn the page)

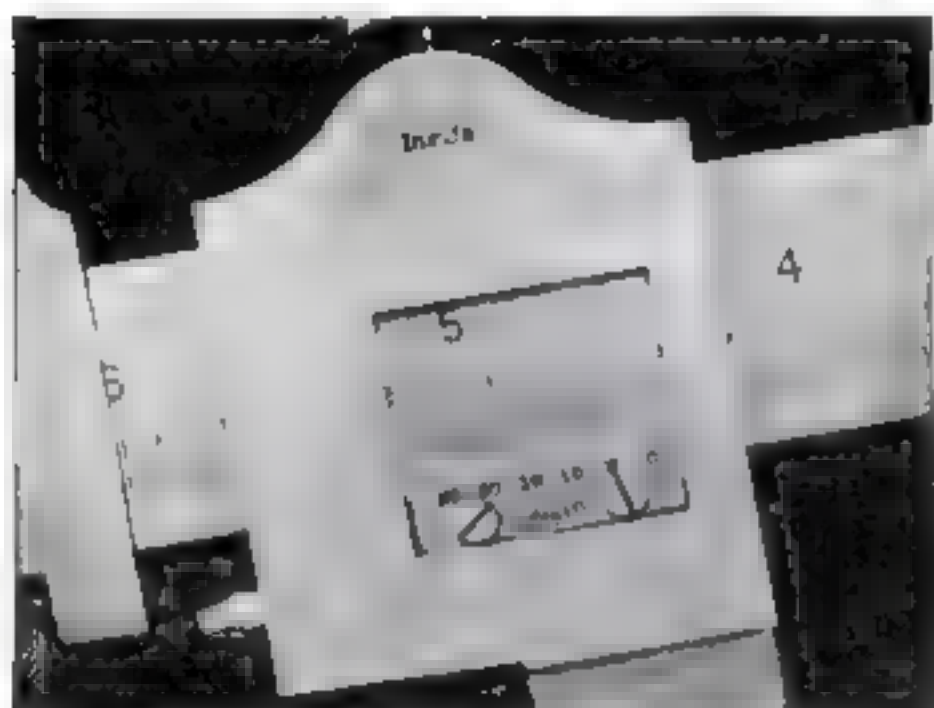




13 Above is the caliper reading of the outside diameter of the turning shown on page 165. Left of the vernier zero is 6.000", the vernier reading is .011", and the full reading is 6.011"



14 Steps on the jaws of vernier calipers are for measuring inside dimensions. A sense of feel developed with experience makes it possible to set the jaws accurately for correct readings of .001"



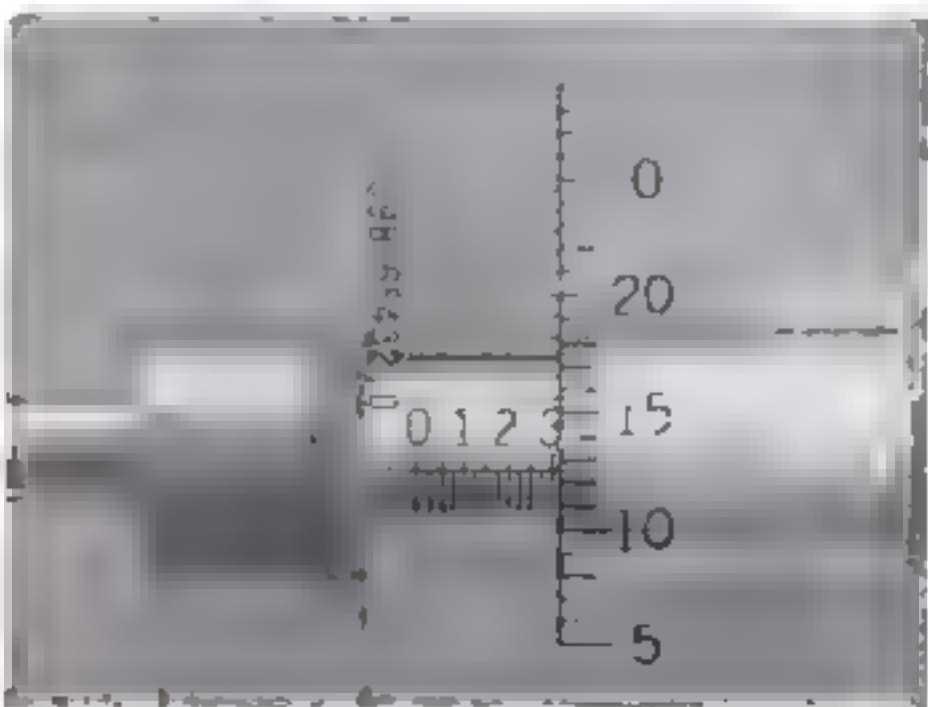
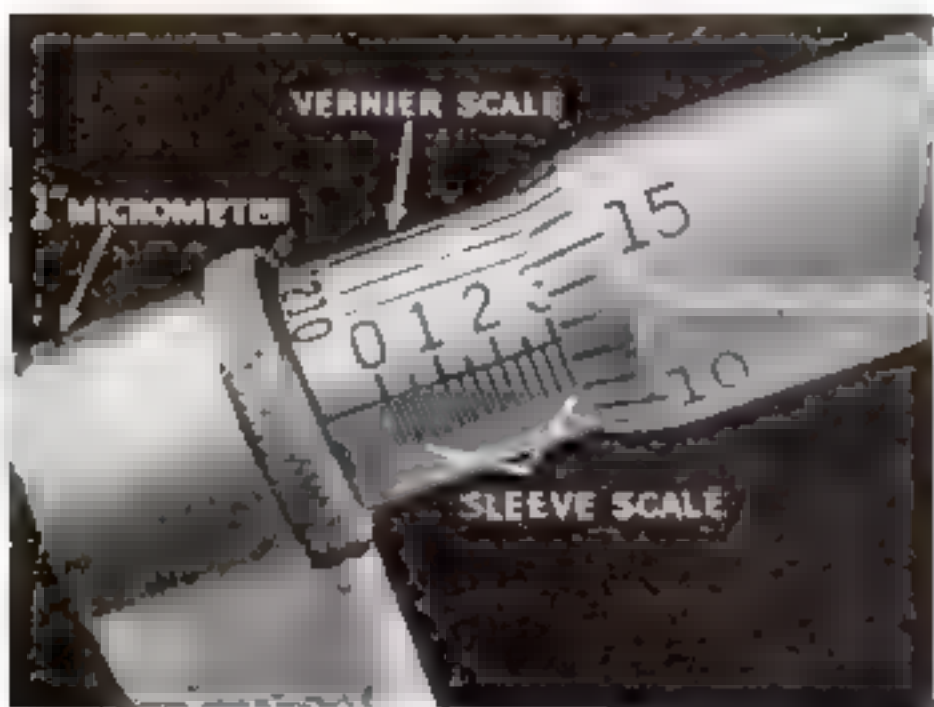
15 Each side of vernier calipers is marked with a scale, one for reading outside dimensions and the other for inside. The latter is read from right to left, but the principle remains the same

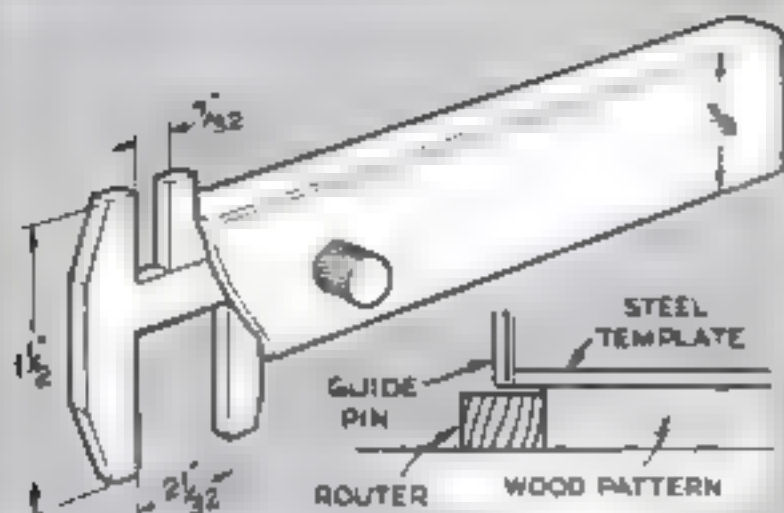


16 Here is a close-up of the reading in the bore of the workpiece at top. A magnifying glass shows the vernier is aligned at 24, not at zero. The reading then is 4.475" plus .024", or 4.499"

17 The vernier principle is applied also to the micrometer. Main barrel divisions are .025", thimble-scale spaces are .001", and 10 horizontal divisions on the barrel take the reading to .0001"

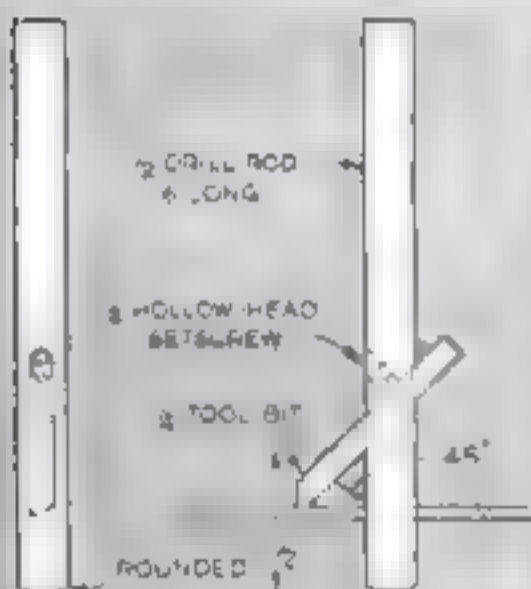
18 Here the scales are unrolled. Begin reading the visible main-scale .3000"; then add the thimble .0120" below the main horizontal line and the aligned .0005" on the unrolled scale at left





DIFFERENTIAL CALIPERS prevent errors in cutting wood patterns for airplane parts. Steel templates for sheet-metal parts are made full size, but from these must be made wooden patterns exactly $\frac{7}{32}$ " smaller all around. These are cut with a router revolving directly beneath a pin touching the edge of the steel template. To preserve the $\frac{7}{32}$ " difference required, the pin must be exactly $\frac{7}{16}$ " smaller than the router, but as the bits

are sharpened frequently, their diameters become less, and smaller pins must be used. The calipers, devised by Harry Becher, an employee in the Northrop Aircraft, Inc., plant at Hawthorne, Calif., have two sets of jaws, as shown in the drawing. When the larger pair is closed over a router bit, the smaller ones, being $\frac{7}{16}$ " closer together, automatically close to the correct size of the pin required.



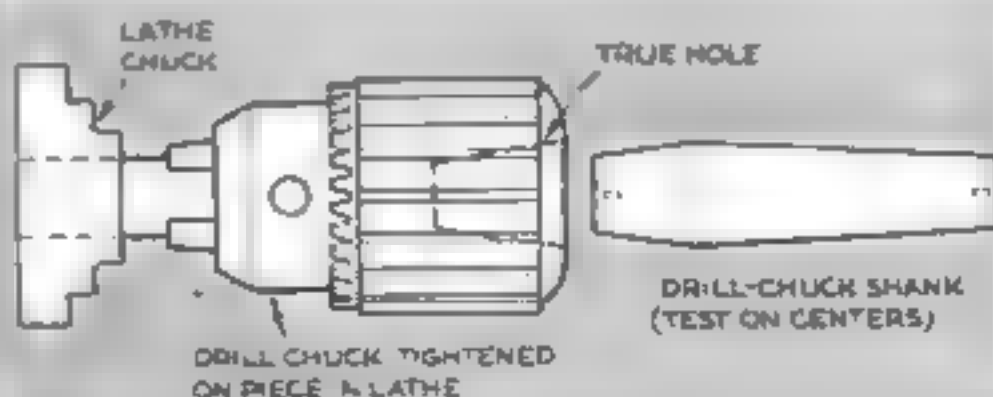
CLEAN, CIRCULAR HOLES up to about $2\frac{1}{2}$ " in diameter can be cut easily in sheet metal with this trepanning tool employing a standard $\frac{1}{2}$ " square high-speed tool bit. The tool is chucked in the drill press. It will handle work up to $\frac{1}{8}$ " or even more in thickness. The holder is made from a 6" length of $\frac{1}{2}$ " drill rod into which a square hole is cut $1\frac{1}{2}$ " from the end and at a 45-deg. angle to accommodate the bit. A hole is drilled and tapped at right angles for a setscrew.

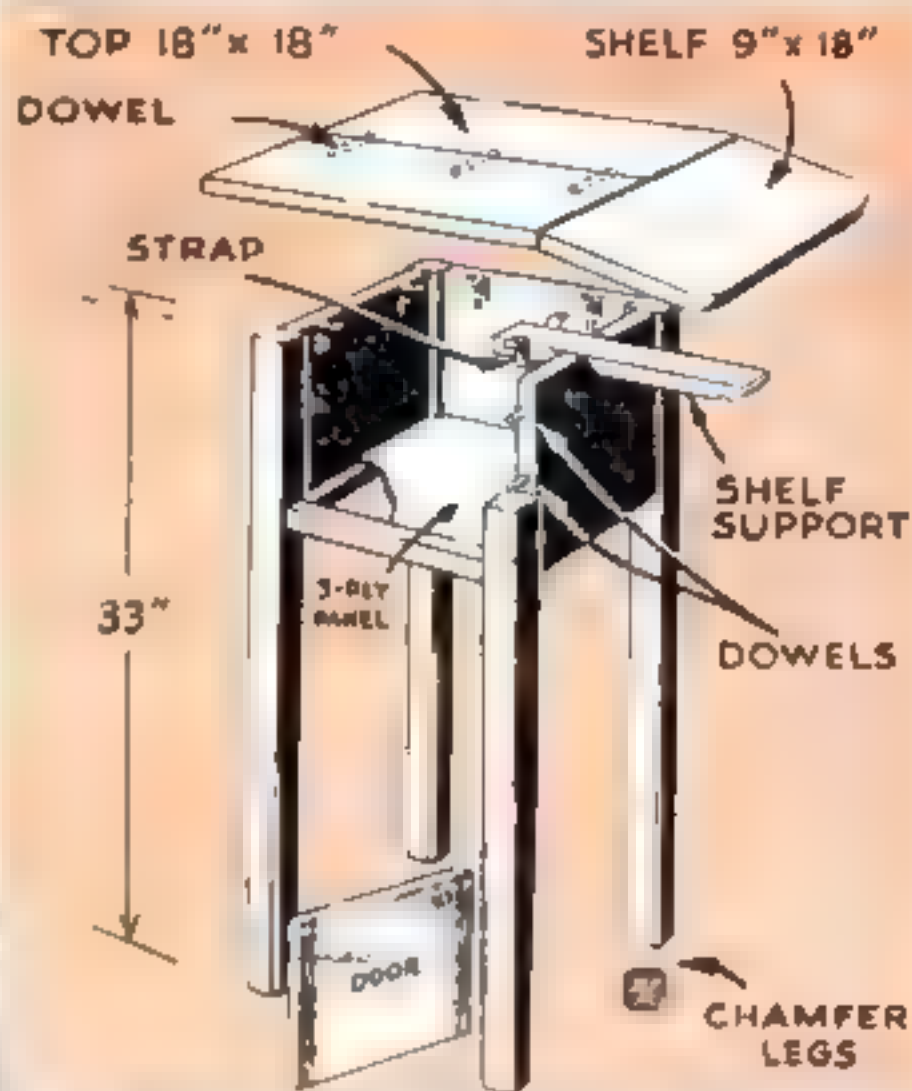
To use the tool, drill the work to take the pilot at the exact center of the hole to be cut; then set the bit, ground as shown, in the holder at the approximate radius desired and lower the pilot into the work until gauge lines can be scored for accurate measuring. Cut almost through and finish from the other side.—JAMES CANT.

DRILL-PRESS CHUCKS suspected of running out of true can be tested readily in the lathe. Remove the chuck and its taper shank from the drill press. If the shank has center holes, check it first by mounting it between centers in the lathe and chalking it. If it is shown to be bent, a new shank should be obtained.

Next, chuck a 3" piece of $\frac{3}{4}$ " stock in the lathe and shoulder a 2" length to a diameter slightly less than the capacity of the drill chuck. Tighten the chuck jaws firmly on this piece, insert the shank in the end of the chuck, and run the lathe slowly. If the end of the shank runs out of true, the hole in the chuck is at fault. In

this case, remove the shank and, with the compound rest at the correct angle, take a light boring cut to true up the tapered hole in the chuck. This method is also useful when new jaws have been installed in a chuck.—GROVER C. BAIR.





To keep kitchen tools at your fingertips, a utility table like that shown above can be invaluable. Although small enough for one to move it easily near an outlet when using an electric mixer, it has a handy extra drop leaf and a compartment for storing articles

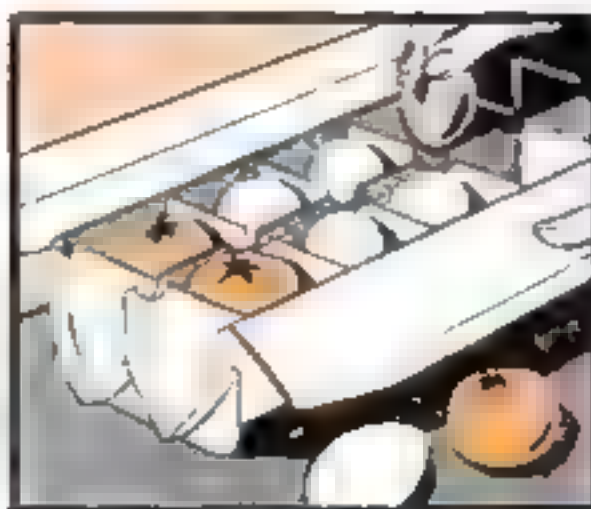


A stamp moistener is a convenient holder and applicator for liquid shoe polish, especially if you're traveling. Its sponge tip is pointed and applies the polish evenly around the trim

Door chimes that fail to operate properly may have a greasy film on the plungers. This can be removed with carbon tetrachloride or cleaning fluid, applied with a small oil can



If fishing lines are coiled on old adhesive-tape metal spools, they won't get tangled and are protected against nibbling mice



Picnic foods such as soft fruit and hard-boiled eggs are easy to carry and less apt to crush if packed in cardboard egg cartons

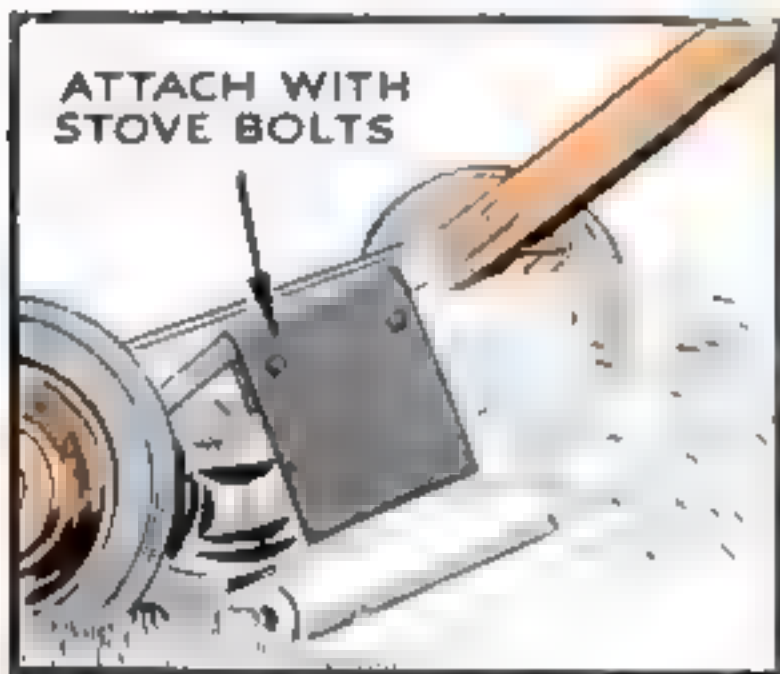


Two lengths of waxed paper laid in a gelatin mold so that their ends extend over the sides help to loosen and turn out gelatin



**NAILS
PREVENT
LOOPS FROM
SLIPPING
DOWN**

Ties that are used to prevent heavy plants from falling over will not slip down when looped over nails in the sticks. The nails should be inserted so that both ends will protrude. Always use cloth for making ties



**ATTACH WITH
STOVE BOLTS**

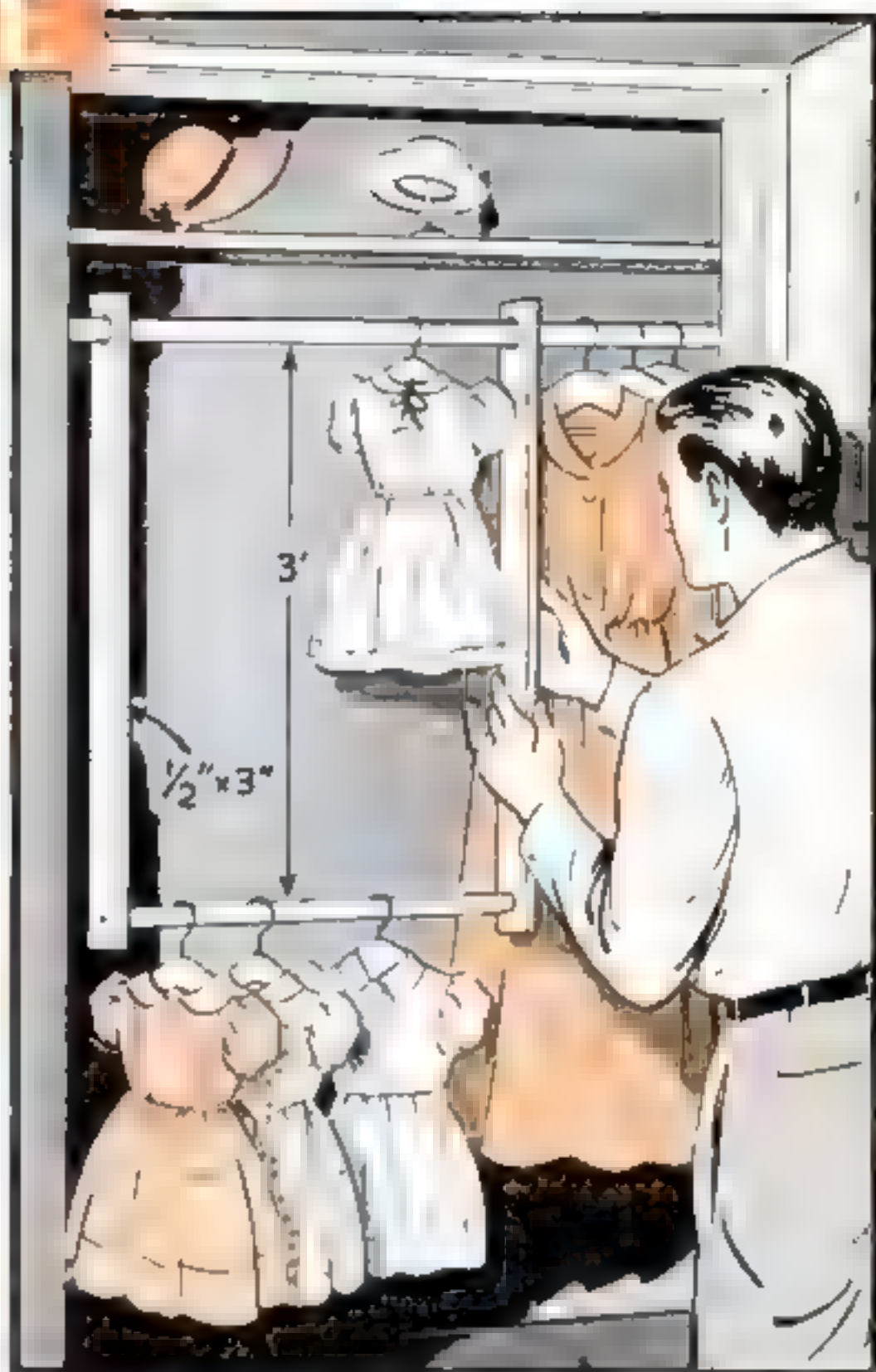
When mowing the lawn, if you are slowed up by cut grass that is thrown over onto the uncut portion, a shield behind the mower on the side toward the uncut grass will deflect cuttings the other way. It can be made from a piece of tin and fastened with bolts



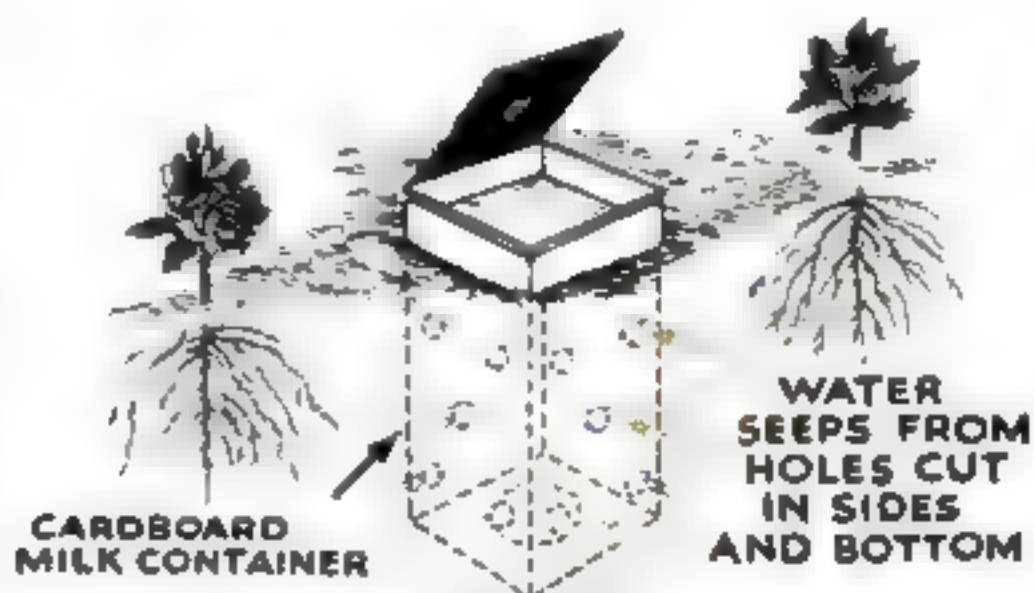
**DOORKNOB FITS
ON SQUARE TOP
OF FAUCET**

An old doorknob makes a very satisfactory handle for an outdoor faucet if you find that the regular handle is broken or lost

JUNE, 1944



If a grownup and child share one closet, the arrangement of their clothing is improved by suspending from the main rod a second, shorter rod that the child can reach. Above will be room for the child's less frequently used clothes and also for short adult apparel such as skirts and blouses



**CARDBOARD
MILK CONTAINER**

**WATER
SEEPS FROM
HOLES CUT
IN SIDES
AND BOTTOM**

Water poured into quart-size paper milk containers buried upside down keeps plant roots moist. Liquid fertilizer also can drain through the side punctures

How to Judge a Secondhand Boat

POINTERS ON WHAT TO WATCH FOR WHEN DECIDING IF
A USED CRAFT IS ACTUALLY A BARGAIN OR A BAD BUY



With the boat cradled, sight along the hull lines. Any irregularities may mean cracked frames or loose planks

THOUGH the war has choked off the supply of new pleasure boats, it's still easy in many localities to purchase a secondhand craft. What's more difficult is for the inexperienced boatman to be sure that he is getting a good buy. This is not to suggest that those who have boats for sale are an untrustworthy lot, nor that buying a good used boat has to be a blind gamble. Actually, of course, most sales are marked by good faith on both sides; and the evaluation of a boat can be made with some accuracy by a person familiar with small craft.

Nevertheless, two pitfalls do await the novice in the secondhand market—his own enthusiasm, and the fact that grave defects in a boat are frequently inconspicuous. The remedy for the first is simple: don't be in too much of a hurry to buy the boat that catches your fancy. Many a bad investment has been born of that first enthusiasm, so deliberately forget the attractive features of your prospective purchase, and go all out in the search for defects. Remember that many boats are likely to have some pleasant or intriguing qualities, but that far fewer ones will really suit you after the novelty has worn off.

It's a good plan to start off your boat-hunting campaign by thinking carefully about the type, shape, and size of the boat you want. There are literally hundreds of

different kinds of boats which will do for other people but which won't meet your needs. Consult more valid motives than a purely personal liking for the lines of a boat, or the chance to pick up an exceptional bargain. Strive to make clear-cut decisions as to where and how your boat is to be used. Remember that, for example, a boat of deep draft, however desirable it may otherwise be, will probably be a headache if only narrow channels cut local shoal waters.

Don't buy a boat that is any bigger than you need, as many a captivated buyer has done. For one thing, a few additional feet of length will raise the cost considerably over a shorter boat of similar quality. For another, upkeep, operating costs, and difficulty of handling will also increase, perhaps more than proportionately. Steer clear of the boat with an unusual shape, and stick to the well-known, tried-and-true designs. Often an owner has invited trouble simply because he fancied "something different."

If repairs are essential, as is frequently the case with secondhand boats, find out beforehand just what you are being let in for. Will the result be worth them? The writer recalls one case of an old boat, presumably sound but with a few parts showing dry rot, which when repairs began proved so far gone that she ended up as firewood.

Small open boats are by far the easiest for the inexperienced person to size up. Serious defects are likely to be obvious; and dry rot, worst of the enemies of small craft, is rare in open boats. Sprung or leaky hulls are more probable, but they will usually be evident upon close inspection. Occasionally a leaky small boat will continue to leak after intensive calking, painting, and soaking, but since this doesn't happen often and since the investment in such a boat is relatively small, the buyer need have less caution than with larger craft.

With bigger boats, power or sailing, the wise buyer's inspection becomes much more searching. Nevertheless, a number of important points are more or less self-evident. For example, has the end of the stem which projects above the deck been kept painted?

By
ELON JESSUP

Bare wood here is not a good sign, since rain may have soaked into the end grain or trickled down into the rabbets and spread damage in several quarters. Most of the tricks that an experienced judge of boats uses are as simple as this

If possible, it's best to examine the boat both when she is cradled ashore and when she is afloat. Of the two, the cradled position usually tells the most. Start off by strolling around the boat, studying both bottom and topsides. Look for any rust spots which may show through the paint; they may indicate that the hull fastenings are in poor shape, and bad fastenings are sometimes difficult to replace. Keep an eye peeled for any evidence of electrolysis, a reaction often occurring when submerged nails, screws, or fittings of iron are located near similar objects of copper, brass, or bronze. In extreme cases, the resultant corrosion may leave few sound fastenings on the boat.

Examine the gunns be-



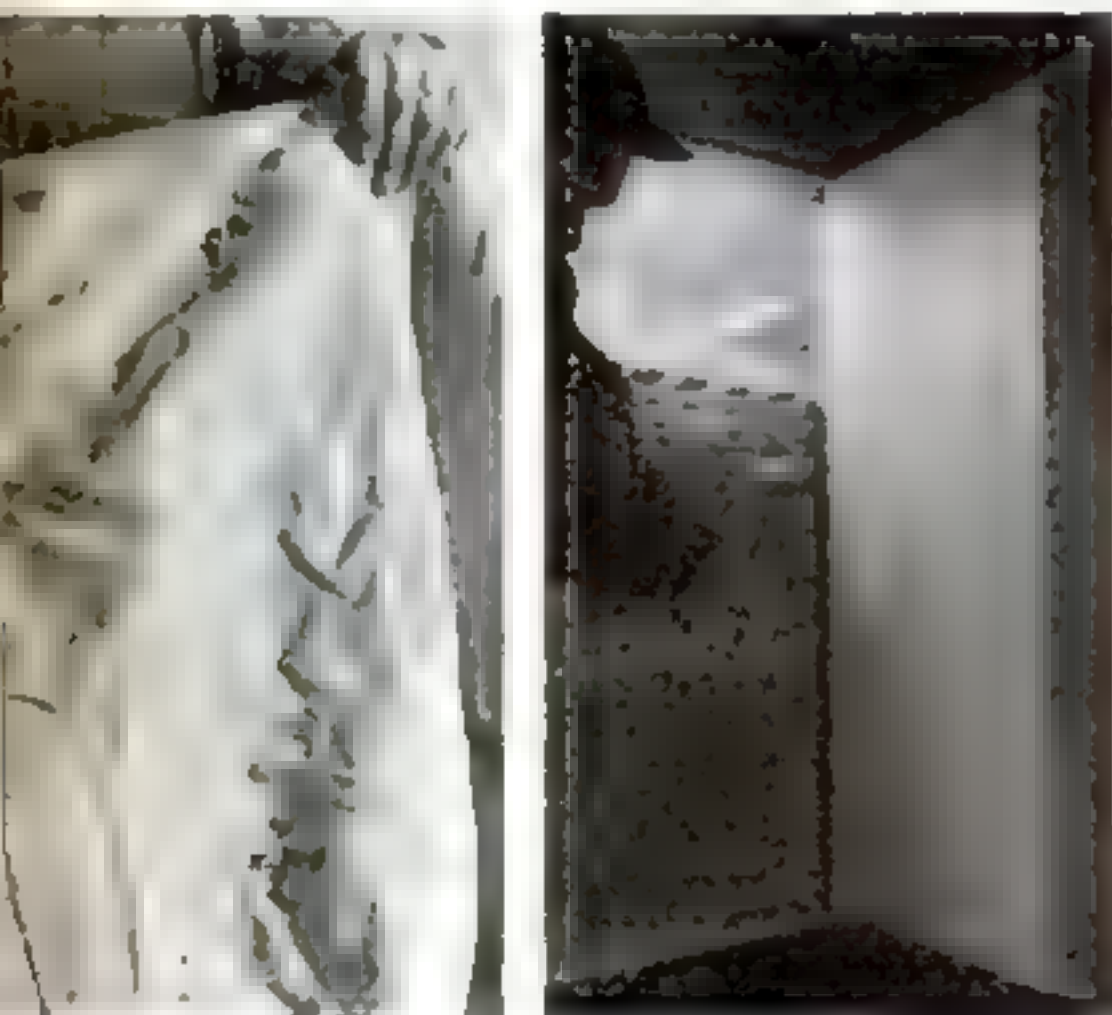
To make sure boating is all pleasure, the prospective buyer will want to make a careful inspection. At the left below, a dark rust patch probably means the plank fastening is gone. The stem center should always be kept well painted to prevent rot. At the right, a knife point should barely enter sound oak.





If wire stays and shrouds show rust, test them as shown or else scrape off the rust to see how deep it goes. Right, a boat that has had time to swell shouldn't leak continuously

Look over the sails for mildew and rips. The icebox, below right, is frequently the place where dry rot starts, so all wood in the vicinity ought to be inspected with great care



Note the wide check in the lower spar. While a crack of this size is scarcely an asset, it's not serious. Putty in a check like this one might invite dry rot



low the water line with care. The fact that a seam is open is not serious in itself; it will usually swell tight when the boat is returned to water. A seam which is not structurally sound—particularly one that has "gone hollow," that is, has had the inner, abutting edges knocked, worn, or rotted off—is likely to give persistent trouble. Not even recaulking can be counted on to help much. Sometimes you will find the seams covered with battens, in which case careful investigation is advisable since it may mean that they have "gone hollow."

You can secure a good general view by stepping back a few paces and sighting along the bottom and topsides. The surfaces ought to be completely smooth. If any seam or plank extends beyond the prevailing smooth curves, it probably means that something is wrong, perhaps that a frame has been cracked or a plank started off. One good way to test suspected regions is to tap the outside of the hull with a hammer. Loosened fastenings will be indicated by a rather hollow sound, while rotted wood will sound somewhat mushy.

In addition, get down and sight along the keel. Since it is the backbone of a boat, you'll have cause for doubts if it is warped, split, or weakened in any way. If the boat has been used in salt water, examine the keel closely for the presence of salt-water worms. Poke the keel in a number of places with the point of a knife, since the holes may be there but covered with putty and paint. If you do find worm destruction, it isn't so serious if the damage is confined to the deadwood, since leaks will not result and affected areas can often be cut out and replaced. Look especially for worms in those parts of the keel where the paint has been rubbed or knocked off.

If the opportunity offers, the local reputation of the boat itself is worth investigation. For example, casual and

Here the buyer is probing the deadwood for holes eaten by salt-water worms. Unless damage is widespread, the affected parts can usually be replaced with sound wood



judicious inquiry will sometimes reveal that a boat is known locally for being a bad leaker, or a gasoline hog, or a wet boat in a choppy sea. The grade of workmanship originally put into her and the sort of care she has since received are other matters which should be looked into, especially when you poke around inside.

First of all, size up the facilities below for ventilation. Has the boat been designed to receive an abundance of fresh air below decks? If not, you may be in for some significant discoveries. Stale air combined with dampness—from rain or condensation, not salt water—breeds dry rot, the nemesis of neglected craft. Dry rot is a fungus growth that thrives in damp wood to which air has insufficient access. It spreads readily, weakens the wood, and in time leaves nothing behind but dust. The blight is easily prevented by plenty of ventilation, but once it has spread widely the boat is a goner.

As a rule dry rot will occur first in inaccessible, ill-ventilated places such as the far recesses of the bilge. The area around and behind the icebox is another likely spot. Unless an icebox has been well insulated and the boat well kept, the icebox will in many cases start a plague of dry rot. In your search for it, open all lockers and take up the floorboards. Give special attention to the garboard planks, and in the case of a centerboard boat, look closely around the well. Your tools during the search will be a flashlight and a pocketknife or ice pick. (Some boat experts prefer the latter, but a knife is more often used.) Jab the point into the suspected wood, identifying rot by the ease with which the point sinks in. Don't forget to make allowance for a naturally soft wood such as cedar.

If dry rot is discovered, the boat need not necessarily be condemned; many a staunch craft contains some. Let your decision be governed chiefly by the location and amount of dry rot. Wherever it is found, the wood will have to be taken out and replaced with sound lumber. One or two planks may not be difficult, but if the blight turns out to be general, the boat is worthless.

The frames should come in for examination during your search for dry rot. Even if they pass muster on this score, they may show cracks large enough to denote a structural weakening, especially at the abrupt turn of the bilge. If any are cracked, they may have to be supplemented with new ones, and the bill for this should be included in your calculations of the true cost of the boat. While you're below, look also for old highwater marks that may give a clue as to how much the boat has leaked.

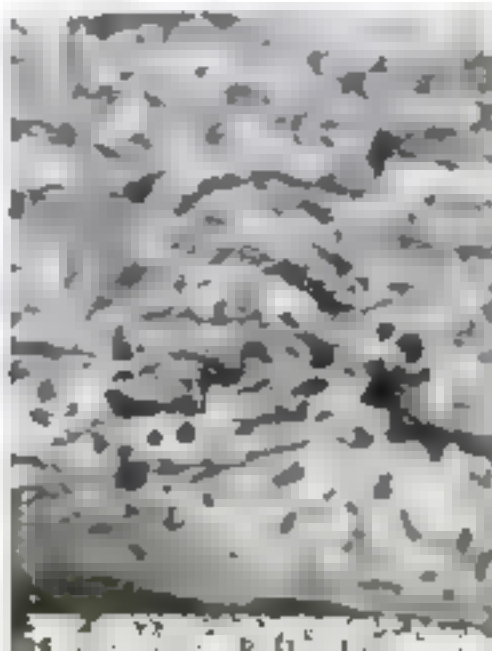
If you're considering a sailboat or an auxiliary, inspect the sails for both mildew and tears at the points of strain—measures that are particularly important if the sails are more than three years old. Similarly inspect the spars as well as the standing and running rigging. Wire shrouds may show rust, often just above the turnbuckles; scrape some off to see how deep it goes since a shroud that threatens to snap under strain isn't a contribution to peace of mind. You'll probably find that the spars show checks, some of them perhaps quite large. As a rule, though, there is not much harm in these checks. In fact the fresh air that is admitted may even help protect the spar against dry rot, whereas checks that are elaborately puttied may encourage it.

The best—and practically the only—way to test the power plant of a boat is to start and run it yourself, preferably under circumstances that will let you measure fuel and oil consumption. Make sure if you can that corrosion has not seriously attacked the cooling system, and that the exhaust is conveniently placed and either well protected or water cooled. Be suspicious of excessive vibration. It can come from a sprung, misaligned, or poorly supported shaft, a defective propeller, unsatisfactory motor mountings, or incomplete antivibration insulation.

Finally, be sure to examine the fuel system with an eye toward safe, vapor-free operation. Be certain that the tank or tanks are in good condition, and that the filler pipe and vents are placed so as to minimize the fire and explosion hazard.

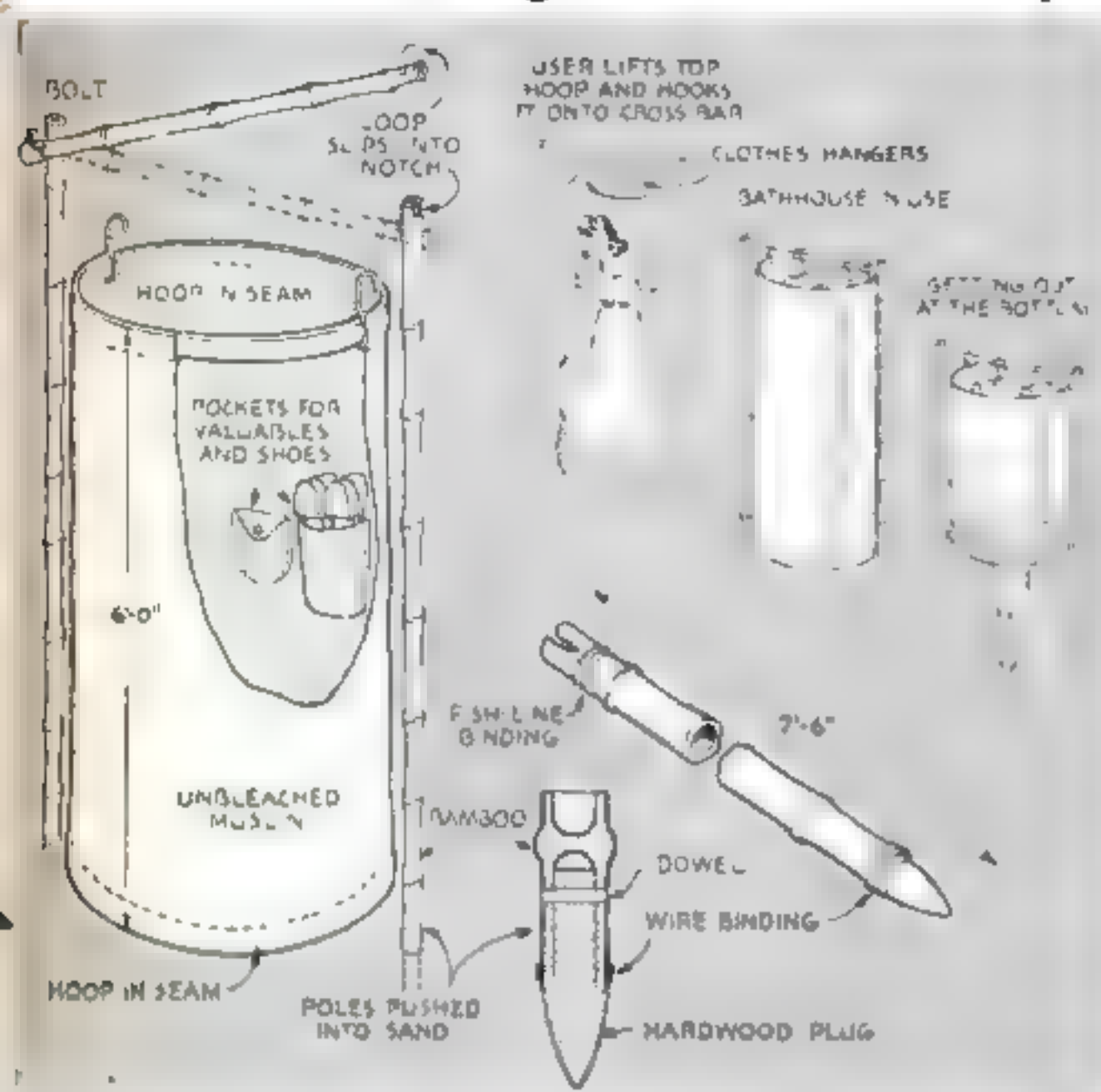
If you suspect that the plank fastenings are bad, or that a frame is cracked or rotten, sounding by hammer taps may help confirm the diagnosis

Below left, marine worms chewed up this timber. Right, a pair of $\frac{1}{2}$ " copper bolts that have been destroyed by electrolytic action with neighboring fittings of iron



BARREL-HOOP BATHHOUSE

Portable Dressing Room Can Be Set Up Anywhere on the Beach



DRESSING at the beach is simplified with this collapsible bathhouse that consists of two vertical poles, a horizontal rod, and a couple of yards of unbleached muslin sewed to two barrel hoops. It weighs but a few pounds and can be folded into a small space.

The poles and rod can be of bamboo or any type of wood. Notch the upper end of one pole and drill a hole in the other. Attach hooks to the upper hoop for hanging on the crosspiece. Pointed hardwood plugs on the lower end of the poles can be pushed easily into the sand. Pockets sewed into the inside of the muslin cylinder will be convenient for holding shoes and valuables.

If you make the vertical poles in two or more sections that can be taken apart on dismantling, the folded bathhouse will be compact enough to carry on a bicycle with ease.—HI SIBLEY.

Comfortable Lawn Chairs Spruce Up Your Outdoor Living Room

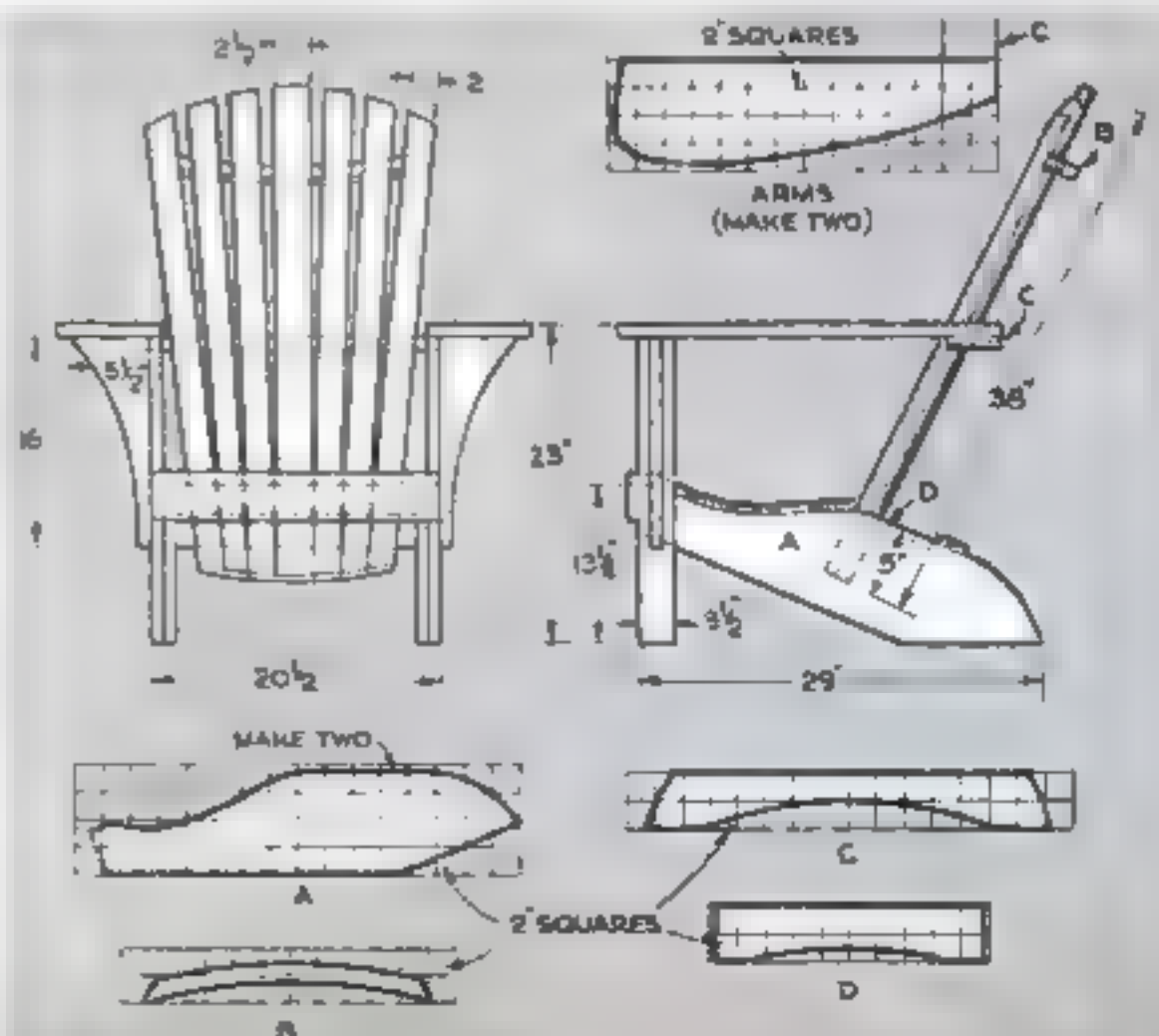
COLORFUL chairs for lawn or garden can be made in the home workshop from common white pine or cypress and will give service for years. Finished with a good grade of house paint, which can be renewed every few seasons, and assembled with brass or galvanized screws, they will stand much hard wear.

Lay out all parts, including the cleats at the back but not the back boards, bandsaw them to shape, and work the edges smooth with a spokeshave. Then assemble the frame.

Saw boards for the back roughly to length, attach them temporarily to the cleats, and mark them for shaping, after which they may be taken off, cut to proper size, and then reassembled permanently on the cleats. If desired, widths of the boards for both the back and seat may be changed.

Assemble the chair with the

screws and joints set in thick white lead to guard the wood at these points against moisture; then putty the screw heads. Sand well, taking care to round all corners and the front edge of the seat.—WILLIAM FREEMAN.





The spiral groove on the mount, which makes sharp focusing easy, can be cut on the lathe, as at left. An outside diameter of 1" is the standard size for most 16-mm. lens mounts. The photo above shows it before assembly; below is the mount as it is used.



Bigger Home Movies in a Small Room

By ERVIN WALTERS

VARYING the size of the screened image without moving your home-movie projector is possible with this projection-lens mount. It makes use of two salvaged achromatic lenses, available at \$4 for the pair, which have a diameter of about $\frac{3}{4}$ " and a focal length of 4", giving an equivalent focal length of some 2" when mounted close together. It's also possible, of course, to use other corrected lenses that you may be able to salvage from old cameras, opera glasses, and the like.

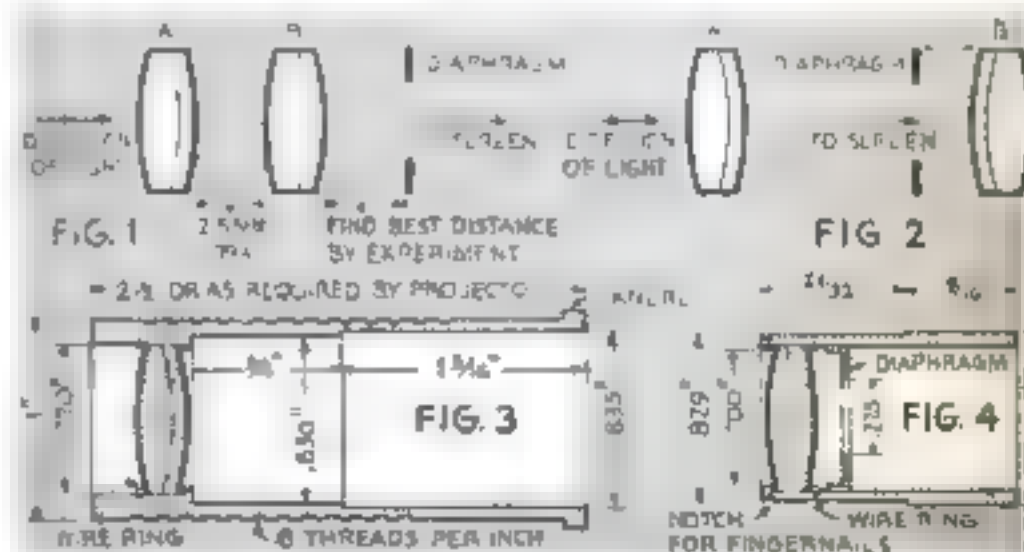
The mount can be machined from brass or plastic, and even heavy cardboard might be used. It consists of an outer shell, Fig. 3, with a spiral of eight threads per inch cut around it, and an inner tube, Fig. 4. The inside of the larger is bored to two diameters that differ by .005"; the outside of the small draw tube is turned to the same diameters less .001". The spiral on the larger tube engages a spring lug on the projector for focusing.

When the inner tube is inserted small end first, the lenses are in the position shown in Fig. 1. If the inner tube is reversed, the lenses are as shown in Fig. 2, increasing the equivalent focal length. At a fixed throw—lens-to-screen distance—Fig. 1 would give the largest movies and Fig. 2 the smallest. Intermediate image sizes are achieved by placing the inner tube part way in, facing

in either direction. The mount is focused whenever the inner tube is readjusted.

A fingernail groove at one end of the smaller tube aids in removing it when it is in one position; it can be removed when in the other position by inserting a finger in the open end. The metal or cardboard diaphragm is placed a few millimeters from lens B; a little experimentation will reveal the best location.

Experiments will probably also suggest modifications of the idea. For example, old achromatic combinations may be found which will achieve the desired effect when combined with the regular projector lens. The focal length of the latter can also be varied with supplementary lenses of the type made for use with cameras; a positive lens will increase image size at a given throw and a negative one will reduce it.





Taking Pictures with Your Enlarger

By Walter E. Burton

HAVE you ever tried projection photography? It's a somewhat shy cousin of projection printing and is usually associated with photomicrography. No camera is required, as in making paper negatives (see PSM, Nov. 1943, p. HW 530), yet it produces better photographs of some sub-

jects than can be generally obtained by ordinary photography—and with nothing more than a conventional enlarger that has a reasonably good lens.

The method of making a projection photograph is not unlike that of making an ordinary enlargement. In the latter,

you simply photograph the image of the negative on a sheet of sensitized paper. If you substitute some object such as a piece of lace for the negative, you can make an excellent likeness by going through the same procedure. The light from the enlarger lamp illuminates the lace from behind; the lens projects an image onto the easel; and a sheet of enlarging paper captures that image. You can use a piece of film instead of paper.

This method of photographing objects by transmitted light and projection is the same as that used for making photographs by transmitted light through a microscope. But there is one difference. specimens photographed through a microscope are generally very small, while those photographed in the enlarger are comparatively large.


Whether paper or film is used, a negative is made first. Paper is cheaper, is available

in various contrasts, and makes negatives 8" by 10" or even larger. Ordinary enlarging paper is affected only by blue light—sometimes an advantage since it produces sharp images with a relatively poor lens; at other times a drawback because colors do not record proportionately. Papers having orthochromatic and panchromatic emulsions are faster than most enlarging emulsions. They were developed for special cameras used in copying letters, checks, and the like.

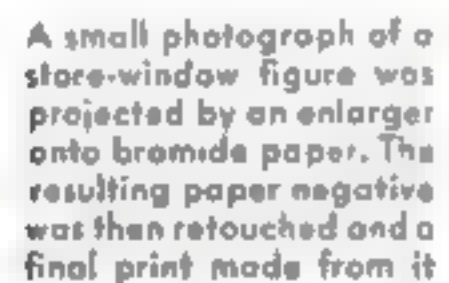
Contact printing from the paper negative gives a remarkably sharp positive print. It is possible, too, to enlarge a paper negative if larger positive prints are desired.

One of the subjects most successfully handled with projection photography is printed matter appearing on only one side of paper. Stamps can often be copied for albums better and more easily by an enlarger's transmitted light than with a copying camera. The stamp is placed in the negative carrier, printed side toward the lens, and projected onto sensitized paper. The resulting negative is used like any other paper negative to produce a positive print of surprising sharpness. Watermarks and other textural details of the paper frequently show, and sometimes they add interest.

Matter that is printed on both sides of a sheet can be copied if the area is appreciably smaller than the largest negative the enlarger will handle. Translucent material



Two negatives, at left made in an enlarger from original subjects. That of "nature's parachute troops" is from milkweed seed held between glass. The feather shows up in detail and, being white, looks more natural in a negative than a positive



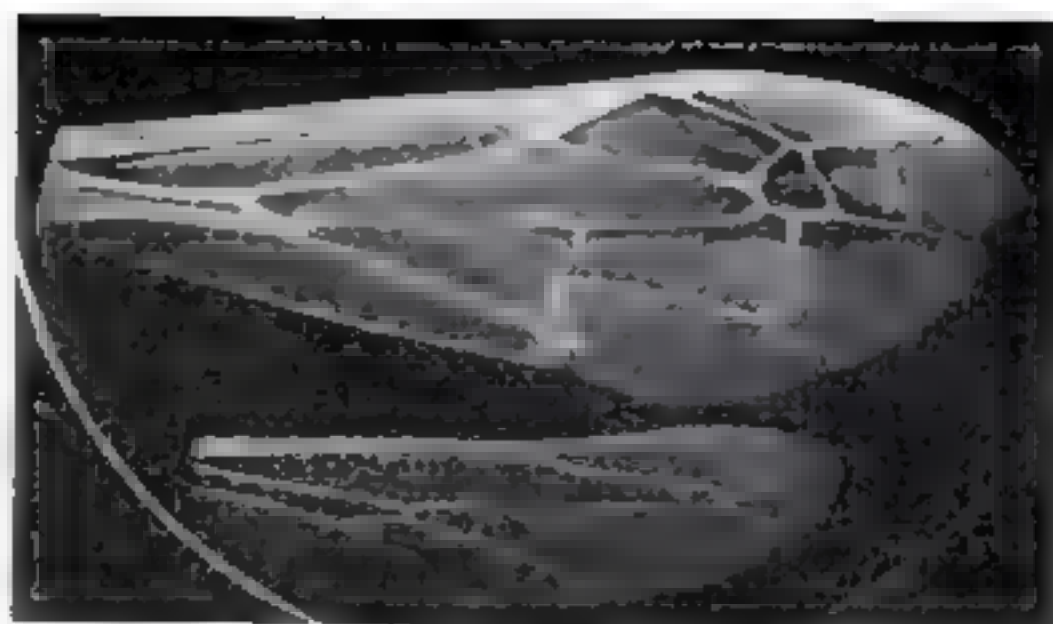
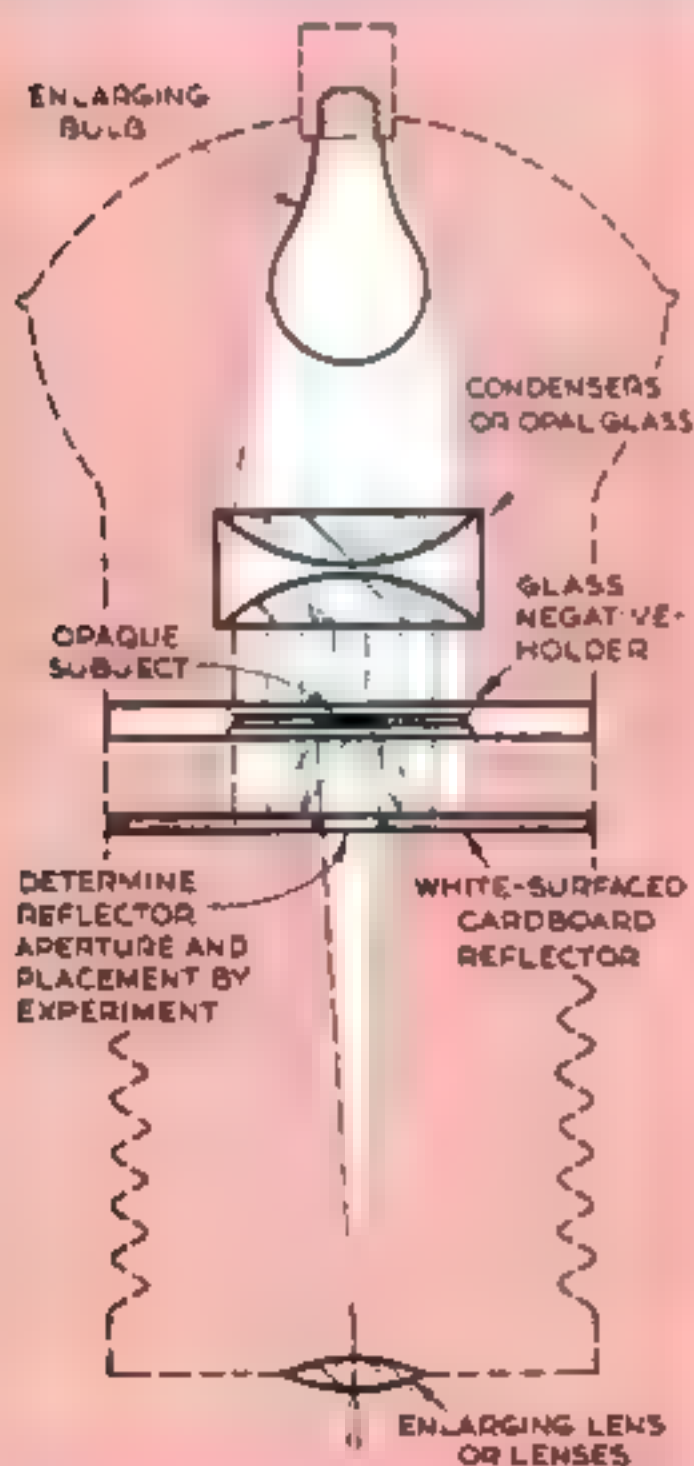
A small photograph of a store-window figure was projected by an enlarger onto bromide paper. The resulting paper negative was then retouched and a final print made from it



must be backed with black paper or cardboard to make it opaque. Place the subject in the negative carrier with the side to be copied toward the lens; then in front of it, at a distance at least $1\frac{1}{2}$ times its narrowest dimension, place a white cardboard reflector or heavy white paper in which a hole has been cut the shape of but somewhat smaller than the area to be copied. Installation can usually be made conveniently in the bellows or housing between the lens and negative carrier. Experiment to get the best distance and the best size for the hole in the paper or cardboard reflector.

Light from the lamp passes beyond the subject, strikes the reflector, is diffused back over the area to be copied, and from there travels through the hole in the reflector to the lens. Unless the lens has a depth of field sufficient to sharpen the edge of the hole, the edge of the negative will shade off softly into white.

The reflector arrangement is shown in the drawing. It can be made a permanent



Wings of a wasp magnified by projecting them in an enlarger. Fine detail is shown in the negative



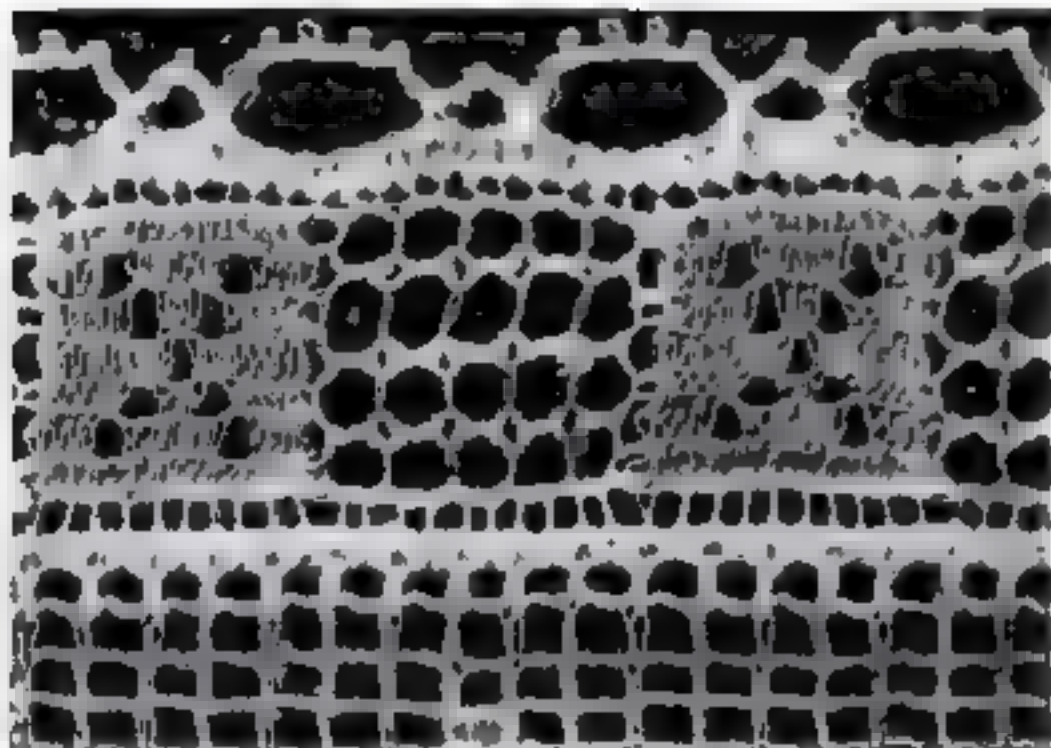
This is a positive of grass specimens stained on a microscope slide and then enlarged many times



Silhouette negative of a small machine part that was projected in the enlarger to show contours

setup by replacing the white reflector with a ring of small lamps to be used instead of the regular enlarger lamp.

Lace, crocheted work, woven fabrics, and the like are best sandwiched between glass for projection. Frequently both the negative and positive print will show detail of threads and fibers that escapes the eye in the original. The negative is often preferred when the subject is white or light in color because it looks more natural.



A negative of white lace looks more real than a positive

Biological subjects and small machine parts can likewise be photographed, but with the latter, if there is considerable thickness, the image may not always be true because of

the varying angle of the light. Insects, seeds, leaves, and the like are usually held between glass or immersed in bubble-free water, as in preparing temporary microscope slides. A cardboard frame can be used between glass slides, if desired, to limit flattening of the subject.

Almost any enlarger may be used, but a vertical type will be found more convenient for keeping the subject in position. The regular lamp will generally serve, although with a condenser enlarger, frosted and clear bulbs may be interchanged for softness or more contrast. A miniature enlarger is best for small subjects, but comparable results are possible by fitting a 5" by 7" or other enlarger with a 1" or 2" lens.

In all cases, of course, use the lens that gives sharpest results. Stop down to the critical aperture, if you know it, for very thin subjects, such as stamps, and still further for thick ones. Otherwise try $f/8$ or $f/11$ as a general diaphragm setting.

PHOTO IDEAS

REMOTE SHUTTER CONTROL

for use in making natural self-portraits can be rigged up simply by establishing a connection with a long wire from a magnetic synchronizer mounted on the camera to the flash-gun battery case held in your hand. Then when sitting for your own picture, all you will need to do to trip the shutter of the camera from a distance is to press the button on the flash-gun battery. This setup for remote control of shutter action will also be found useful in outdoor nature photography, where a camera must often be operated from a distance if one wants to catch candid shots of wild life.



CARDBOARD NEGATIVE CARRIERS that are efficient and dustproof can be made from two pieces of cardboard cut to fit the enlarger carrier. Hinge them together with tape and cut in each a rectangular hole the size of the exposed portion of the negative. Lift the upper sheet, lay the negative over the hole in the lower, and glue four small pieces of heavy cardboard at the corners of the negative, as shown at left, to enable immediate centering. Then notch the corners of the hole in the upper sheet to fit these centering guides. The carrier handles strip as well as cut film.

Improvised Power Attachments Churn Butter Quickly for Home Use

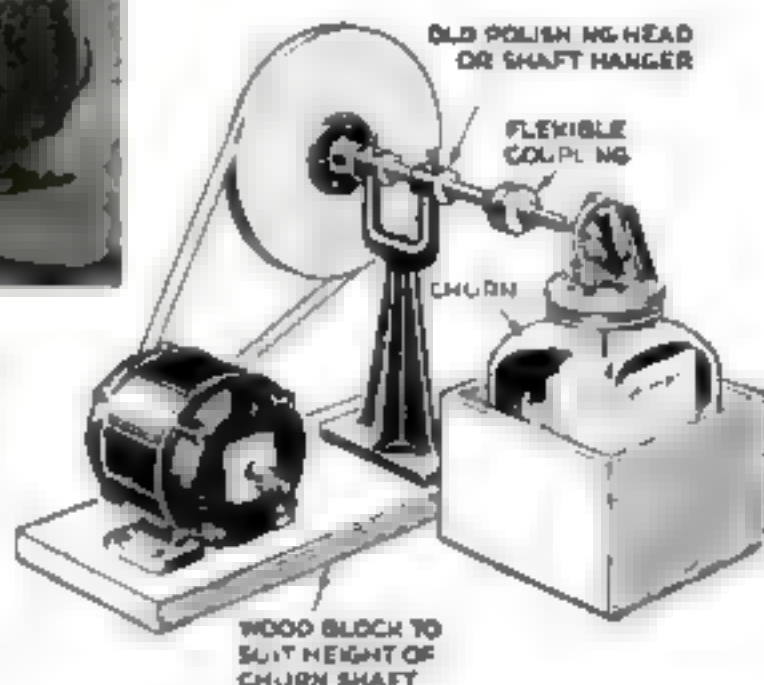
CHURNING small amounts of butter for personal use takes from 30 to 60 minutes when a hand churn is employed, but the time can be reduced to about 15 minutes by equipping the churn with one of the two power attachments shown at the right. In addition, the labor will be cut drastically.

Either setup calls for an electric motor of not more than $\frac{1}{4}$ hp. The motor is screwed to a wooden base in both arrangements, and the churn is steadied in a tight-fitting box. In the photo, a 12" wooden pulley has been clamped between the flanges of a small arbor chuck, the jaws of which are tightened on the crankshaft of the churn. Power is transmitted by a $\frac{1}{2}$ " V-belt from the 2 $\frac{1}{4}$ " motor pulley. The drawing shows a method requiring a polishing head or shaft hanger.—LEONARD TIMM.



An arbor chuck attached to the pulley grips the churn shaft

Below, a setup that makes use of a polishing head. The drive is through a flexible coupling



Concrete Watering Bowl and Feed Trough Cast in Simple Molds



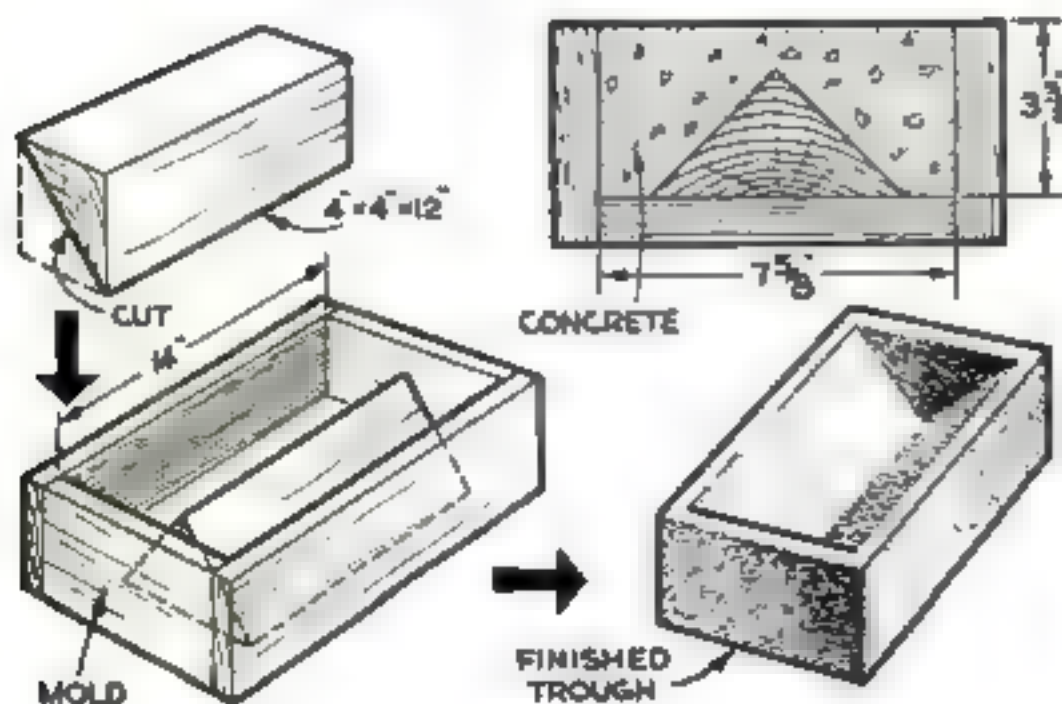
Press in the inner form while the concrete is still soft. Left, the watering bowl in use

CONCRETE watering bowls, like the one in the photo, can be molded for poultry yards without recourse to special waterproofing compounds, while a feed trough for chickens can be cast without difficulty by using a simple mold.

To make the bowl, grease a wooden or metal receptacle to serve as the outer form. Pour into it concrete mixed of 1 part Portland cement and 2 parts medium-coarse sand. Embed wire reinforcement in the mix as illustrated, tamp out air bubbles, and employ a small, ungreased bowl to shape the inside of the casting, weighting it in place until the concrete begins to harden. Then remove the inner bowl and use a large spoon to trowel the inside of the casting to a smooth finish. Repeat the troweling at five-minute intervals.

For the feed trough, construct a box as shown in the drawing, and nail to its bottom a triangular piece formed by cutting a 12" four by four in half along one diagonal. This piece forms the depression in the trough. After the concrete has been poured and allowed to harden, the finished cast can be shaken out easily if the box sides have a slight outward slant.

DESIGN FOR FEED-TROUGH MOLD



HOW TO DUPLICATE A LOST KEY



By Harold P. Strand

WHEN you have put off getting an extra key and lose your last one, what then? It is, of course, much easier to duplicate a key from a model, but it is by no means an impossible job to make one to fit a pin-tumbler cylinder lock if the original key has been lost. Locksmiths are called upon frequently for this type of work, and it can be done as readily by the handy amateur.

The first step is to remove the barrel of the lock from the door, take off the back cam, and open the barrel to get at the pins. If the barrel has a sliding cover, this can be tapped off so the pins can be removed and the cylinder taken out. Hold the barrel with the cover uppermost, and tap just enough to expose only one hole at a time: then carefully drop out the tiny coiled spring and the upper and lower pins and put them aside. Expose the next hole and repeat the process until all five sets of springs and pins have been removed, being sure to keep each set in its relative order so it can be returned to its original hole.

Should the barrel not have a sliding cover, try tapping it smartly several times with a hardwood mallet, hitting it over the area of the top pins or on the top edge of the

rim. This sometimes causes the pins to vibrate and to line up temporarily so that the cylinder can be moved forward. Hold the barrel firmly in one hand while doing this, with the thumb pressed against the back of the cylinder, as shown in Fig. 1, and take care not to push the cylinder out so far that the upper pins will fall into the opening. Clamp the barrel in a vise and, with a 4" length of brass or steel tubing of the same diameter as the cylinder, press the cylinder out carefully (see P.S.M., Apr. 1944, p. 180).

If you fail to get the cylinder started after several trials with the mallet, file off the top surface of the barrel (Fig. 2) until the springs are reached. This usually requires the removal of about 1/16" of metal. It is wise to file in such a way that not more than one or two springs and pins will be exposed at a time, and be sure to remove these and lay them out in order before filing further. A new top can be made for the barrel by cutting a thin strip of brass to size and soldering it in place.

Making the key from a blank that will fit into the keyhole is the next step. One with the proper side wards can be obtained from a hardware store or a locksmith. In-

1 When a cylinder-lock barrel is not provided with a slide top, it can sometimes be unlocked by tapping it with a mallet. When the pins vibrate, they often line up so the cylinder can be started from its hole

2 Should tapping fail to open a lock that has no removable top, file the barrel until the springs and pins can be reached, exposing one or two sets at a time so they can be kept in order





3 With the cylinder removed, the key blank put in place, and the lower pins back in their holes, tap each pin lightly with a hammer to spot the top edge of the blank with marks for filing the notches

sert the key blank in the cylinder and replace the lower pins. If their order has been preserved, a new key can be made like the one that has been lost, but where this has been impossible, a new combination can be worked out. Examples of good and bad combinations are shown in the drawing. Where pins are arranged so that long and short ones alternate, the key will be strong and will operate smoothly. In the case illustrated where the long pins have been grouped in the center, this part of the key will be weakened and may break off in the lock if it becomes stuck. Some of the pins in this example are too long, as well, and cause the needless cutting away of strengthening metal.

With the key blank in the keyhole and the pins arranged in the cylinder, rounded ends down, place the unit on a piece of metal and tap each pin with a light hammer, as shown in Fig. 3. This puts impressions on the top edge of the blank for use as guides in filing the notches to match the pins.

The best file to use for this work is a special triangular file with a bevel of 110 deg. to 120 deg., which is about that needed for

5 When the notches have been cut precisely the proper depth, they will cause all the pins to come perfectly flush with the top of the cylinder. Any that protrude slightly can be filed down level



4 These notches align the pins in the lock so the cylinder will turn in the barrel when the key is inserted. They are filed to correct depth, preferably with a special triangular file having a wide bevel

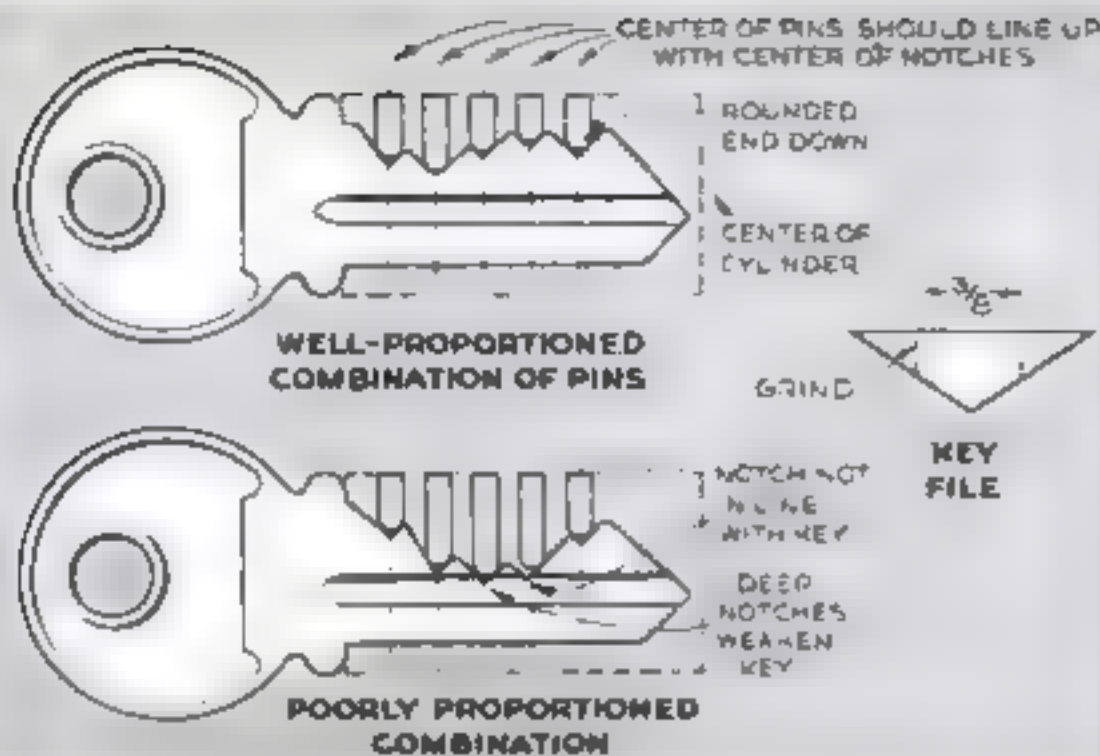
the sides of the notches to make them work easily with the pins. These files are usually made on order for locksmiths and it may be difficult to obtain one new. However, it might be possible to get one from a neighborhood locksmith. The file shown in Fig. 4 and in the drawing was made from a wide file that happened to have the proper bevel. It was ground down to a width of $\frac{3}{8}$ " and did good work.

If a file with a wide enough bevel cannot be obtained, any fine three-cornered file can be used, but it will have to be turned slightly from the vertical in both directions so as to increase the bevel of the notch. It is also possible to use a small rattail file, but the cuts will not be as accurate.

Place the blank in the vise and hold the file exactly on each mark, keeping it level so the cuts will be the same depth through the width of the key. Make each notch a depth that will bring the pin it is to accommodate exactly level with the top of the cylinder, as in Fig. 5. This is important, because if the pins fail to line up just right, the cylinder cannot be made to turn easily in the barrel when the key is used.

6 Perfect alignment of the notches and pins is also necessary, for if any notch should be even slightly off center it will hamper operation. Make a careful check before reassembling the lock





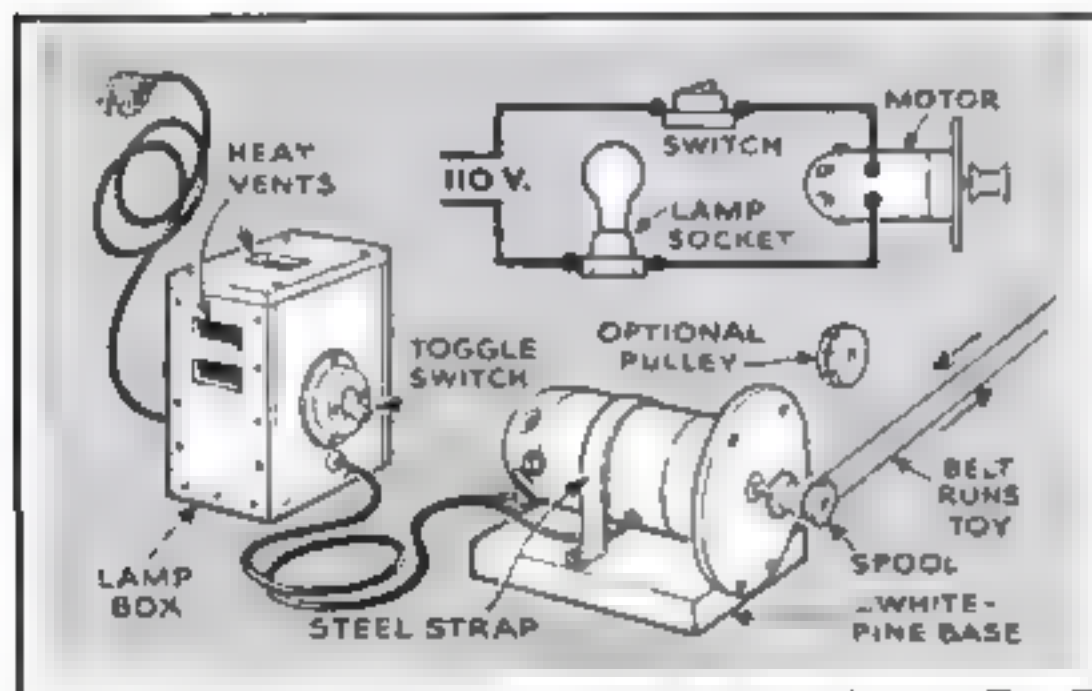
When a new combination of pins is made up, short and long ones should alternate to make operation easy and avoid weakening the key. A wide file with good bevel can be ground down for filing notches

Frequent testing with the key in the keyhole should enable you to avoid making any notch too deep. If one of the notches should be filed too deep, however, a longer pin can be substituted with less work than it would take to file a new blank, or it may be possible to put the short pin in a new position where it will still serve. Should some of the pins protrude slightly above the sur-

face of the cylinder when the job is nearly finished, it might also be easier to file them level than to risk filing the notch too deep. If a new combination is being made, it will save time and minimize errors to leave all the pins protruding slightly, and then to file them level with the top of the cylinder. Check also the alignment of the notches and pins, as in Fig. 6, for even one notch filed off center will result in faulty operation of the key.

A sharp knife or steel-wire brush run across the notches will take off the sharp edges and help the key to work smoothly. Try

it several times in the lock after the barrel has been reassembled and put back into the door. Blow a little powdered graphite into the keyhole if the operation isn't easy enough to suit, but be sure never to use oil in a keyhole—it causes stickiness. Then, just in case, file a duplicate set of keys, using the one you have made the hard way as a model.

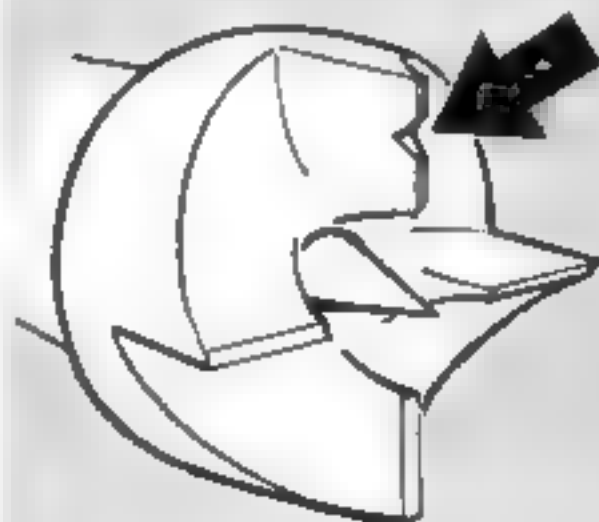


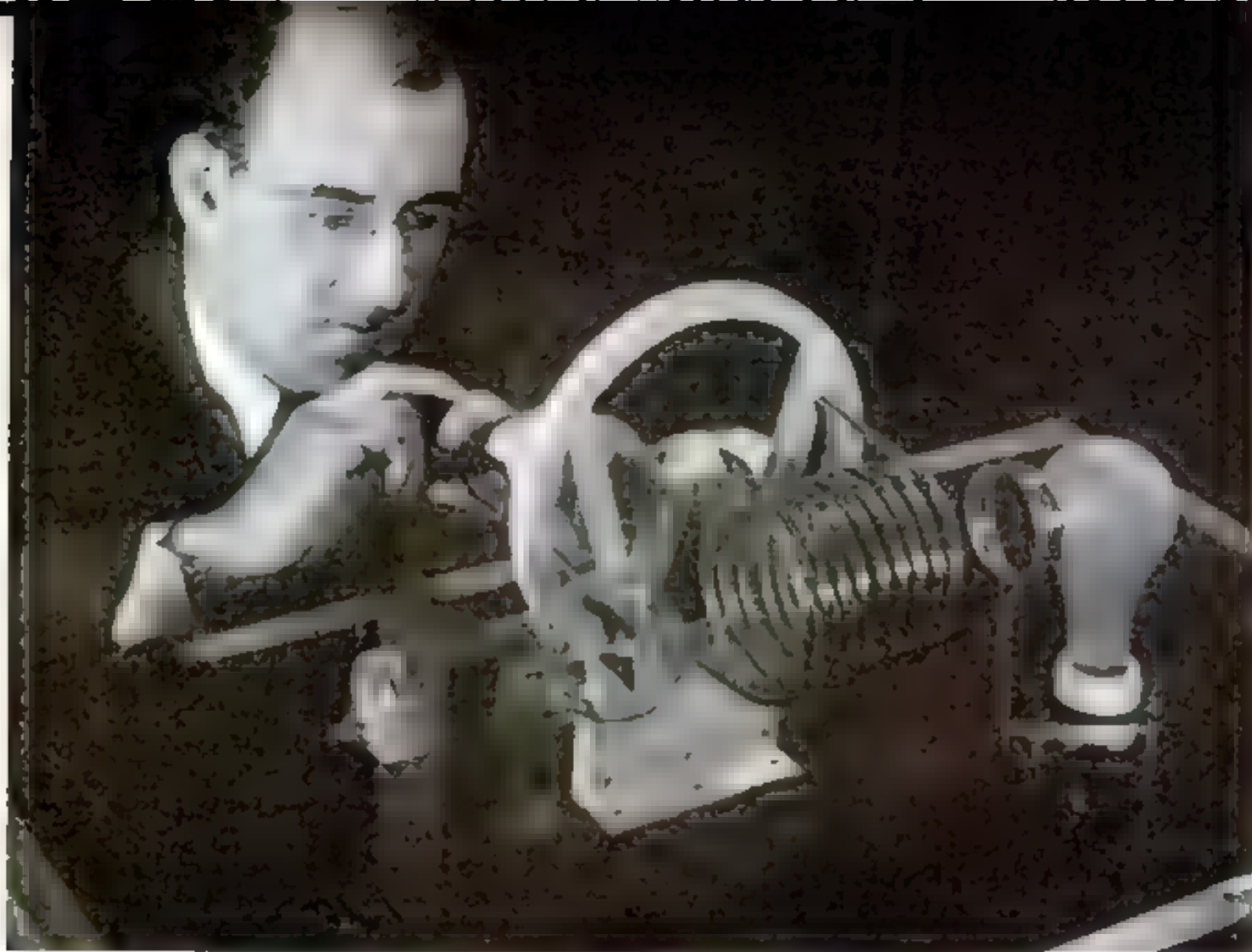
Vacuum-Cleaner Motor Operates Toys

WIRED with an ordinary household light bulb in series to limit its speed, the motor from a discarded vacuum cleaner can be used to drive the moving parts of children's action toys. The fan is taken off the motor and a pulley, which can be an empty sewing-thread spool, is pressed on the shaft to accommodate a belt, as shown above. Extra resistance, supplied by a 40, 60, or 100-watt bulb, will keep such a motor from running away. A 40-watt bulb, for instance, can cut speed from 15,000 to 1,500 r.p.m.—R. S. W.

V-Notch in Spur Center Indexes Lathe Work

WHEN work is to be removed from a wood lathe and to be returned later for further turning, it will prove convenient to have one of the live-center spurs notched, as shown below. The notch will so mark the end of the turning that it can be put back in its original position to run dead true.—WILLIAM T. MORRIS.





R. F. power lights this unconnected bulb, and also makes a metal disk in the glass tube become red hot

RADIO-FREQUENCY POWER

Already Vital to Many War Industries, This Versatile Form of Energy Specializes in Performing the Impossible

By JOHN W. CAMPBELL, JR.

THE equipment and techniques that we now have for generating radio-frequency current are largely the product of research conducted for radio communications. Nevertheless, R. F. power—something vastly different from the simple sending of a signal—has become the fast-growing beneficiary of this same research.

Broadcast transmitters are limited by law to a maximum of 50,000 watts, which is plenty for communications but small change in terms of power. Long ago power engineers stopped thinking in terms of watts and began using kilowatts as units. Now electronic engineers are talking kilowatts, and R. F. power is going to work—soldering, brazing, welding, and tempering metal; firing explosive rivets; drying spooled rayon; baking plywood, treating diseases, cooking foods. Installations of more than 10,000

kilowatts have been made which, in a single application—tin-plate processing—use over 200 times the maximum current allowed a broadcast transmitter.

Yet R. F. power is costly. Generating it calls for huge power-amplifier tubes, with a complicated battery of auxiliary apparatus to feed them. Required are such accessory devices as oscillators, power-amplifier drivers, heavy-duty rectifiers, tank circuits, control circuits, and grid-supply circuits—all involving substantial engineering and construction costs. Then, too, many kilowatts are wasted in generating R. F. current; high-power tubes, cooled by air blast or water, throw away large amounts of the energy fed to them.

With these handicaps, why is more and more R. F. heating being specified by cost-minded industrial engineers? The answer lies in its almost magical selectivity. With high-frequency heating, it is possible to fuse

iron held in an asbestos crucible in a man's hand without heating the hand. It is also possible to heat the hand without warming the iron. A piece of metal inside an evacuated glass tube can be heated without softening the glass; or the glass can be heated without softening low-melting-point alloys sealed inside.

Often it's desirable to manufacture a sort of "soft-boiled" steel—steel that is hard on the outside but relatively soft (and hence tough instead of brittle) on the inside. A soft-boiled egg gets that way because outer layers are heated to coagulation before enough heat reaches the center to harden the yolk; boiling water carries heat to the egg faster than the egg can distribute heat inside. With steel, furnaces can't achieve enough difference between inner and surface temperatures so that quenching will harden the outside and leave the inside soft.

Ordinary power-line current would heat the steel, but would be little help because it heats uniformly. R. F. current, though, behaves very differently. High-frequency currents have a "skin effect"; they flow only very near to the surface, because of the magnetic fields involved. Consequently, R. F. heating will produce "soft-boiled" steel—a metal that is of a glass hardness at the surface but is still elastic and tough within, just right for certain kinds of armor plate, crank bearings, and other special applications.

In manufacturing electron tubes, the elements are assembled within a glass or metal envelope which is then pumped out to a high-grade vacuum. One difficulty comes from the fact that the metal elements themselves are saturated with gases, and in a vacuum, these ordinarily absorbed gases start coming out. Somehow the metal parts must be heated sufficiently to drive out the gases. Since the elements are in a vacuum, heat cannot be applied directly, and not enough ordinary current can be supplied to the plate and other electrodes to heat them. But if the entire tube is placed in the magnetic field of an R. F. coil, heavy currents will be induced in the tube elements, heating them and driving out the absorbed gases. The glass envelope, which would

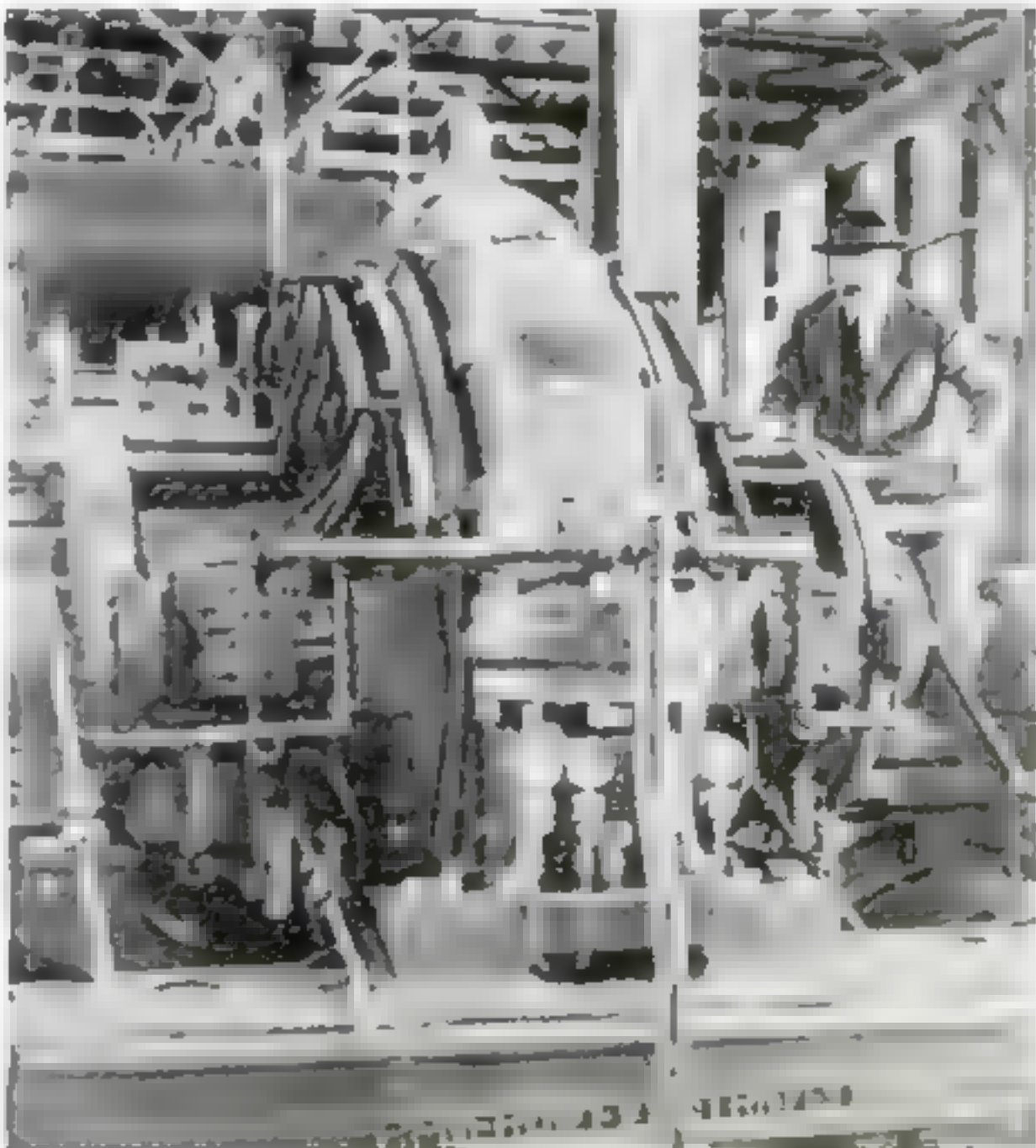
soften and perhaps collapse under atmospheric pressure if it were heated, isn't even warmed.

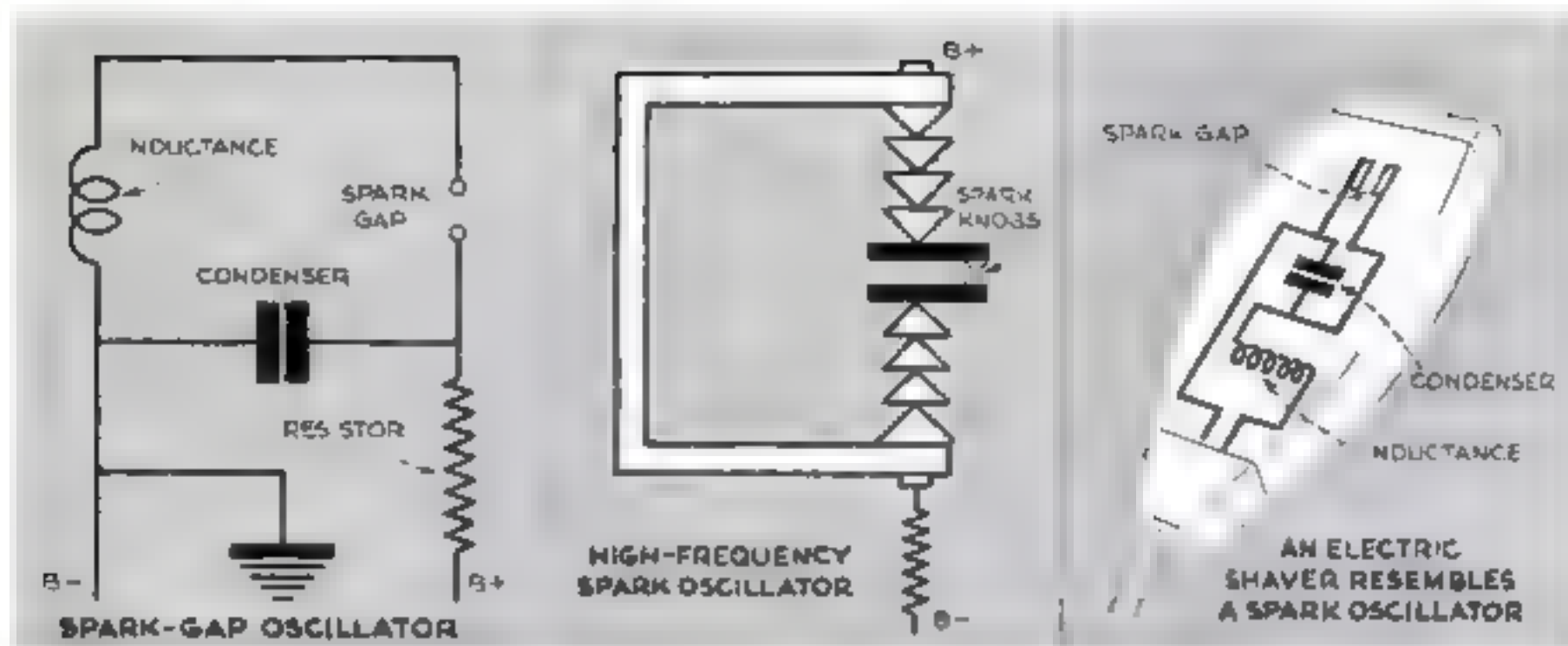
In other applications, heat is wanted in a nonconductor and not in nearby metal parts. To achieve this, the work may be placed between the plates of a condenser to which high-frequency power is supplied. The nonconducting material then acts as a dielectric in the electrostatic field of the condenser. Dielectric losses are normally the bane of the radio engineer, but this time he puts them to work. The losses within the nonconductor heat it, though they do not affect any metallic conductor near by.

Moreover, it's possible to heat one nonconductor without heating another nonconducting material in the immediate vicinity, and then later heat the second without affecting the first. This remarkable blow-hot-blow-cold trick is worked by using different frequencies. Many materials have comparatively low dielectric losses at all but certain frequencies, when their molecules go into a sort of resonance. Thus the first material in the example suggested above might have a heavy dielectric loss at 4.75 megacycles, while the second material might have low losses at this level but might heat readily at 5.32 megacycles.

R. F. power is peculiarly well suited to the manufacture of plywood bonded with heat-setting adhesives. Steam plywood

The Alexanderson alternator, below with its inventor, represented one early attempt at mechanical R. F. generation. Only moderately efficient, it made use of a principle resembling that of the Model T Ford magneto





Above, a basic type of spark-gap oscillator; at the center, one producing ultrahigh frequencies. Note that the spark knobs are on the condenser plates themselves

presses are not completely satisfactory for work more than 1" thick, since to get enough heat to penetrate the inner layers, almost destructively high temperatures must be developed in the outer zones—or else prolonged medium temperatures must be used. With high-frequency heating, an even, controlled heat can be quickly generated inside the plywood, and thickness makes no difference whatever.

Food preparation is another field for high-frequency heating. Because of the time saved, this method may in the future even be able to compete on a cost basis. At present, roasts, for instance, are cooked for hours solely because a low oven temperature must be used to keep the outer layers from burning, and because heat is only slowly transferred within. The same job can be done in seconds with R. F. current. Restaurants of the future may offer everything on a cooked-while-you-wait basis; perhaps a waiter may put a raw potato between two metal plates, press a button, and in a few seconds serve you a steaming, perfectly baked potato.

Physicians, too, make extensive use of "short-wave diathermy," which is nothing more than R. F. heating under a different guise. The characteristic of readily controllable internal warming of bone and tissue adapts the technique for treating arthritis and rheumatism, hitherto often



Multiple soldering jobs can be done simultaneously with a "radiothermic" soldering iron—merely an R. F. coil

An electric razor, as any radio testifies, has all the elements of a true spark-gap oscillator: a condenser, a coil, and a pair of points that function as a gap

treated by external baking. Another use has been to induce an artificial fever as a means to fight some diseases; the intensity of the fever is carefully held at levels which, without harming the patient, will kill or weaken the organisms causing the disease.

High-frequency current is not only extremely selective in the composition and position of the substance which it heats, but it is also remarkably quick and flexible. Ordinary furnaces controlled by thermostatic devices don't have fast reflexes; thermal lag, even

friction and inertia in the mechanical parts of the controls, prevent them from holding temperature to exact levels. But since R. F. heating is virtually instantaneous, lightning-fast electronic controls are useful.

In R. F. equipment for melting tin plate, a strip of steel coated with tin is pulled past an induction coil at speeds approaching 1,000' per minute. A photoelectric cell "watches" the melted tin surface as it races past. To this tube, there is ample time to observe the melted surface, react, and adjust the heat as needed—all while any single point on the speeding strip has advanced but a fraction of an inch.

Other uses than heating have been and are being developed for this astonishing form of electricity. The atom-smashing cyclotron is made possible by R. F. power. A wholly different field is suggested by the

fact that fluorescent lamps can be lighted readily by these radiations. They require neither metallic electrodes nor a heater within the tubes—thus by-passing most present problems of gas-discharge lamps. In one decorative display a small R. F. generator is placed at the base of a Christmas tree, with a wire "aerial" leading up the trunk. The tree is decorated with globes and tubes of different shapes, filled with argon, neon, or helium gas, and mercury or sodium vapor. No connection to the bulbs is necessary to make each lamp glow colorfully.

High-frequency radiations can be directed into fairly narrow beams, making the radio transmission of power theoretically possible. However, there are no signs at present that we can develop planes or cars driven by high-frequency radiations, because only the minute fraction of the power broadcast which hits the receiving antenna could be of use, assuming that we had a reasonably efficient way to use it. Wireless transmission of power might be valuable, though, where physical barriers rather than distance intervene between power source and motor. A sealed stirring motor, for instance, could be run inside a sealed chemical vat without introducing any contaminating leads.

The only satisfactory way of generating

R. F. power is with a vacuum-tube oscillator; mechanical generators are impracticable for modern demands. Historically, the first source of R. F. current which was of experimental value was the spark-gap oscillator, used by Hertz to produce microwaves to test Clerk-Maxwell's electromagnetic theories.

The basic spark-gap circuit, similar to the one devised by Hertz, is shown at the top of the facing page. A potential is built up in the condenser until the voltage reaches a point where the air gap breaks down and becomes conductive. The spark, once started, carries a heavy surge of current that oscillates in the resonant circuit until the energy stored in the condenser is dissipated; then the arc can no longer maintain itself, the condenser is recharged, and the cycle repeats. To the eye and ear, the cycle is so rapid as to appear a continuous discharge.

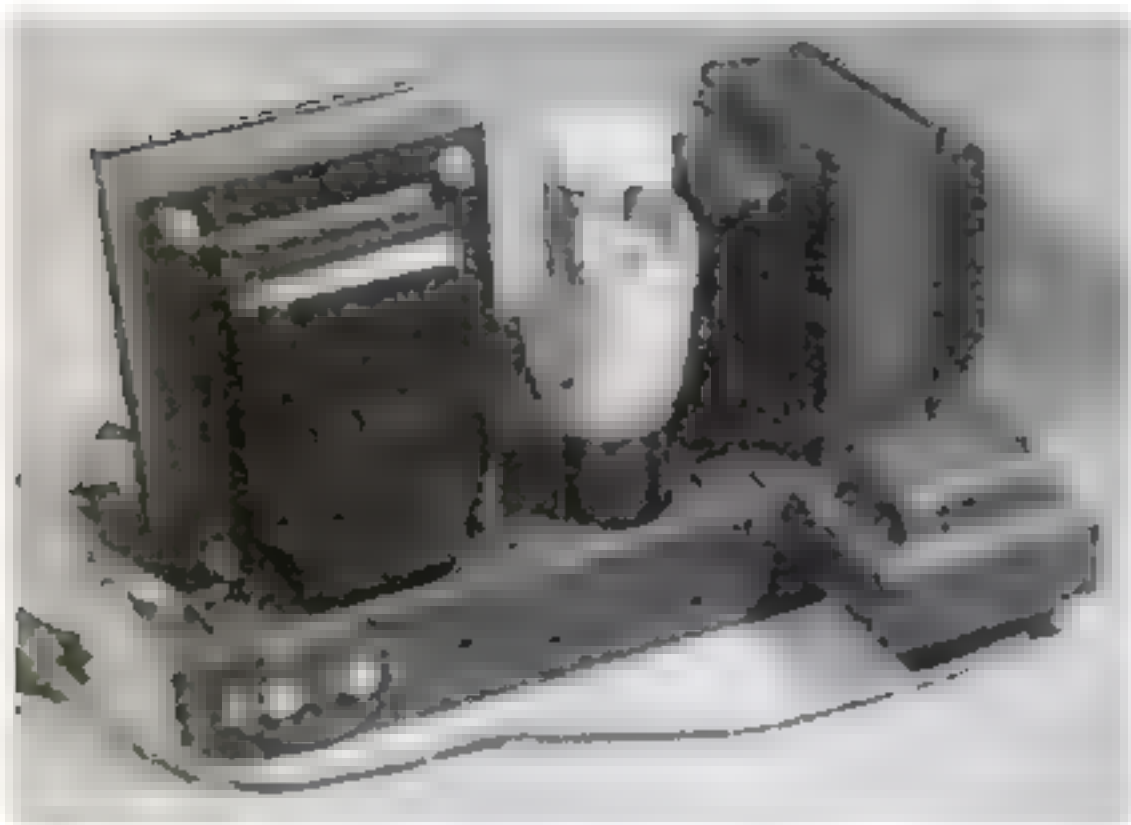
The inherent simplicity and reliability of a spark-gap oscillator is in a sense its most serious drawback. A doorbell buzzer, spark plug, electric motor with sparking brushes, electric shaver, static discharges from clouds, even people walking across rugs can act as a spark-gap oscillator. Since the tuning is broad and there are many harmonics, the radiations are received as static practically everywhere on the radio spectrum

In this press, laminated wooden airplane spars, coated with a heat setting adhesive, are in effect the dielectric of a R. F. condenser. The resultant internal heat quickly bonds the single pieces together.



HEAVY-DUTY CHOKE-INPUT POWER PACK

Servicing Your Radio



In the rear view of the power pack, the transformer is at left and the two chokes at right, the second being the one on the side. Wiring is shown in the view from the bottom

WHERE you find replacement of a power pack difficult, or have trouble with blowouts on a condenser-input filter, this rugged power pack, constructed of salvaged parts and capable of delivering 300 volts at 250 millamp., will give excellent service. It will also provide a well-filtered source of power for a short-wave receiver. The unusually high current rating provides plenty of current for power stages.

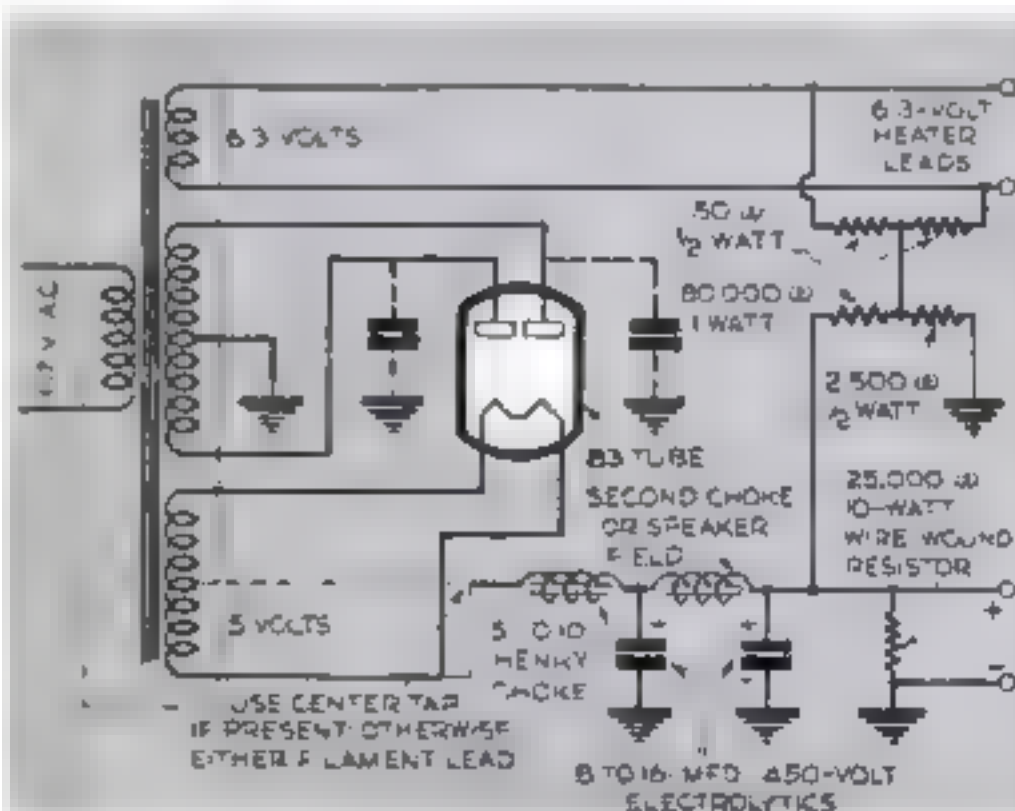
Good voltage regulation is assured by the choke-input filtering feature, which also will prevent the high peak voltages that sometimes blow out even 450-volt condensers when a

mercury-vapor rectifier tube is used. This type of filter gives better voltage regulation than those of the condenser-input type, showing less voltage drop when a heavy current demand is placed on it.

Two .01-mfd. condensers from the plates to ground cancel the annoying hums that are sometimes caused when the R.F. circuits are modulated by the power supply at certain frequency settings while the detector is oscillating. If A. C. hums are encountered, add .25-mfd. condensers across each side of the power line and from the 6.3-volt heater leads to ground.

If the speaker you use is one of the many of the electrodynamic type employing a powerful electromagnet instead of a permanent magnet, you may connect its field coil for use as one of the choke coils in the power pack. This expedient permits the coil to function in two ways, since it will also provide the necessary magnetic field for the speaker. For use on other sets, the power pack will require two chokes.

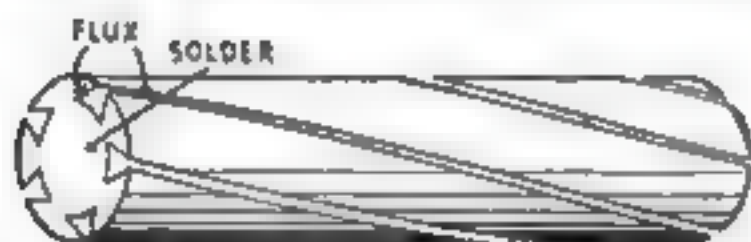
The parts are arranged on a metal chassis with the second choke screwed on one side to allow for greater compactness. An octal socket is used for the outlet connections, while a discarded octal-tube base makes an excellent plug for the outlet cord for the receiver-tube filament voltages and high-voltage taps. Less flash back on starting, but poorer voltage regulation, is possible with a 5Z3 or 5U4 tube



PORTABLE INTERPHONES are being used to speed installations, riveting, and assembly in plane, ship, and other war construction. These instruments, provided with either conventional or throat-type microphones, enable a mechanic working in one part of a plane to communicate with members of his crew in other compartments to coordinate the installation and testing of equipment. A bucker and riveter on opposite sides of a huge fuselage or wing skin can exchange information without hammer signals that might endanger the fabric. The phones were originally developed for flight training.



SPEEDY CONTACT with light operating pressure is obtained with the new open-blade snap-action switch shown at left. It is designed for machine-tool control devices, aircraft landing-gear controls, and other applications, including relays and contactors. Positive snap action is produced by a fast rolling spring that minimizes contact burning. The switch is rated at 15 amp. on 125-volt A.C. Types are single pole, single and double throw, and set and return.

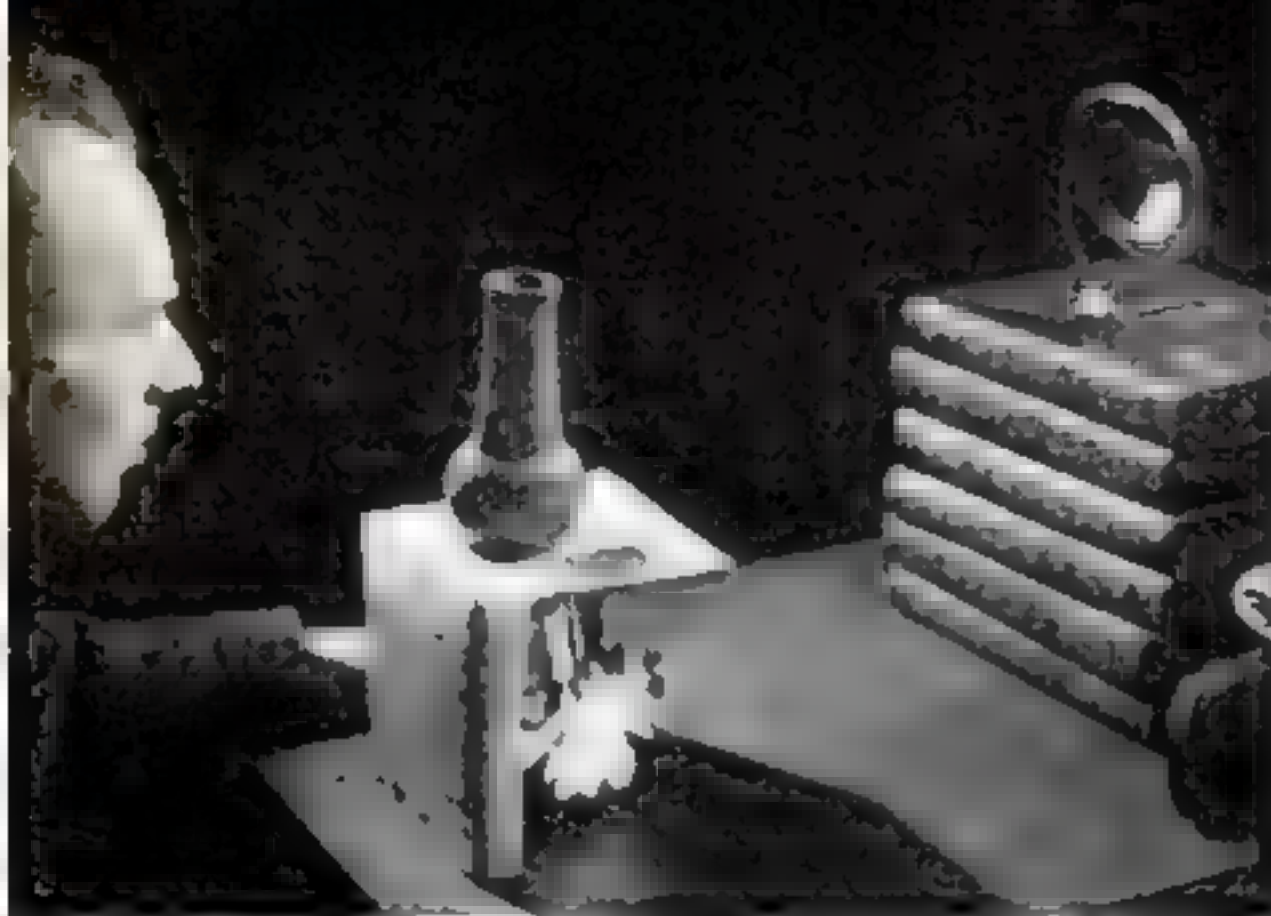


NEW TYPE OF WIRE SOLDER WITH FLUX IN GROOVES

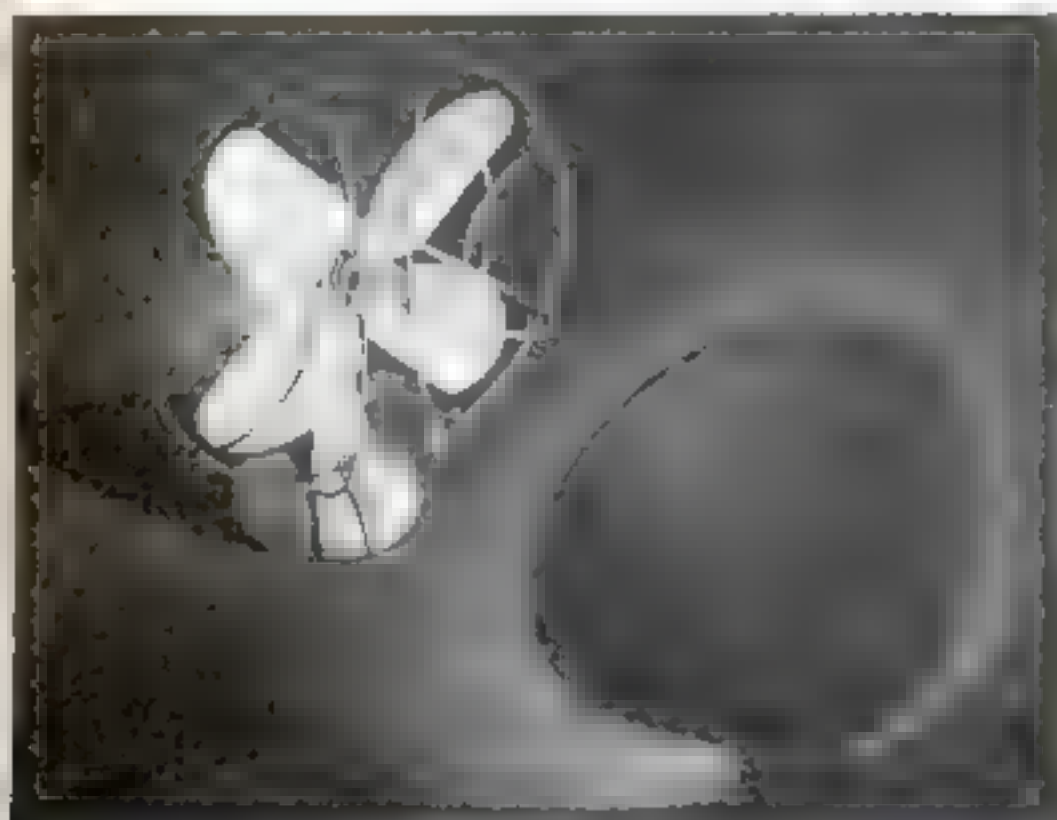
FLUXED WIRE SOLDER containing flux in longitudinal grooves instead of in the core is now on the market. Being on the outside, the flux liquefies and flows onto the work before the solder itself melts, thus, according to the manufacturers, insuring a thorough fluxing of the work for a strong joint. The inconvenience of breaks in the flux is avoided since there are several lines of flux, and a gap in one would be offset by the others. Diameters are standard.

WIRES CAN BE SPLICED quickly and neatly without the use of solder by joining the two terminals shown in the photos at the right. The two parts are identical. A crimped end slips over and grips the end of the wire; then the coupling itself is made with a knife-switch wiping action, as shown, providing contact at four points. The joint can then be protected by an insulation sleeve slipped on readily. Now used in plane installations, the product will be available generally after the war.





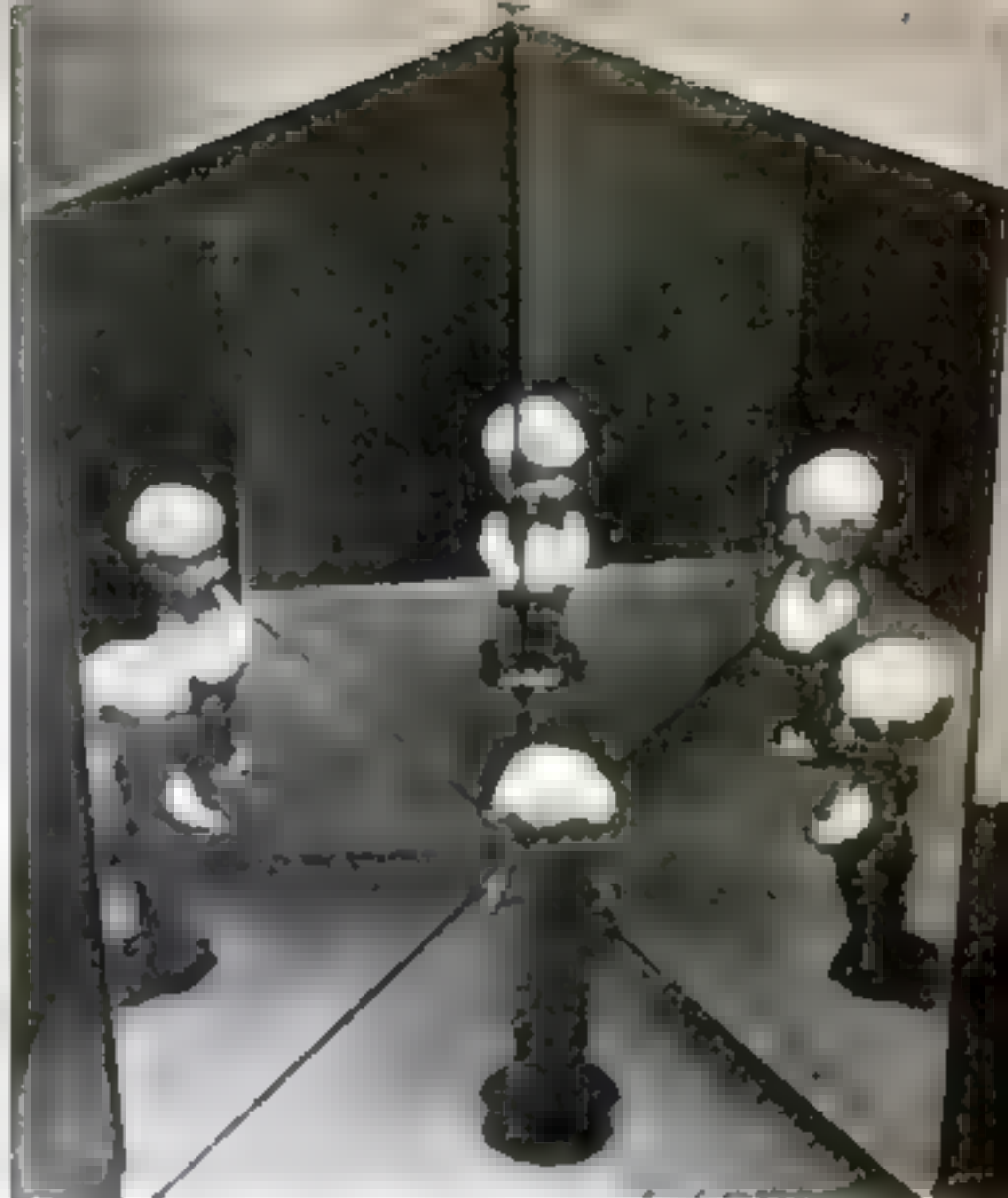
HOW TO DO SOME EXPERIMENTS WITH LIGHT



SHOWING WHAT ISN'T THERE by making an object appear somewhere else is a neat trick to mystify your friends. Reflected in an ordinary concave shaving mirror, an object will appear right-side up if it is *within* the focal point of the mirror; but move it away from the mirror until it is *outside* the focal point, and it will appear magically upside down. As a stunt, remove one end and the top of a cardboard carton, blacken the inside, stand it in front of a concave mirror, as at the left above, attach a flower upside down as indicated, and turn off all lights except a spot or desk lamp. Put an empty vase on the carton and adjust the mirror, and you will find a place where the flower will appear right-side up in the vase if you sight along the top of the vase. With a camera ground glass held on top of the vase, you can prove the image is similar to one formed by a lens.

FANS REVOLVE BACKWARDS or appear to remain still when run in stroboscopic light, which can be produced at home with a small argon bulb. Such a bulb flashes on and off every time 60-cycle A.C. changes—120 times a second, 7,200 times a minute—too fast for the eye. A four-bladed fan appears in ordinary light as in the upper photo at left, but in argon light at exactly 1,800 r.p.m.—one fourth the speed of the argon flashes—the blades seem to stand still, as in the lower photo. This is because you see the blades in position at each quarter turn. Revolving faster than 1,800 r.p.m., the blades appear to turn slowly; running slower than 1,800 r.p.m., they seem to turn the other way. Rebounding air from a card held in front will retard a fan going faster than 1,800 r.p.m.

TO SEE YOURSELF AS OTHERS DO, look into two ordinary mirrors arranged as shown below with their glass surfaces at a 90-deg. angle to each other. Your reflection will no longer be reversed, as in a single mirror. Hold print before the arrangement, and you will be able to read it in the reflection. But don't try to shave in front of it; you might cut yourself. The image you see in the combination has been reflected twice—caught by one mirror and reflected back to you from the other. In the second mirror, the sides have been reversed again. Because of the angles of the two mirrors, you could not see yourself in either of them if the other were removed.

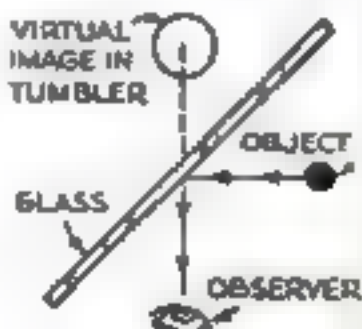


YOU SEE FIVE IMAGES

if you stand two mirrors together with their glass surfaces at an angle of 60 deg. The doll and its reflections in the photo above appear to be standing in a circle. Why this is so can be demonstrated with a circle having the juncture of the mirrors at its center and the object being reflected on its circumference. The position of all the reflections will then also fall on the circumference, as shown in the diagram. This explains why the doll and reflections seem to be in a circle. If you follow the arrows in the diagram, you will see that the two nearest reflections are from the doll itself, while the next two are reflections of the first reflections and the farthest is a coinciding reflection of the second two. An asymmetrical object shows these reverses

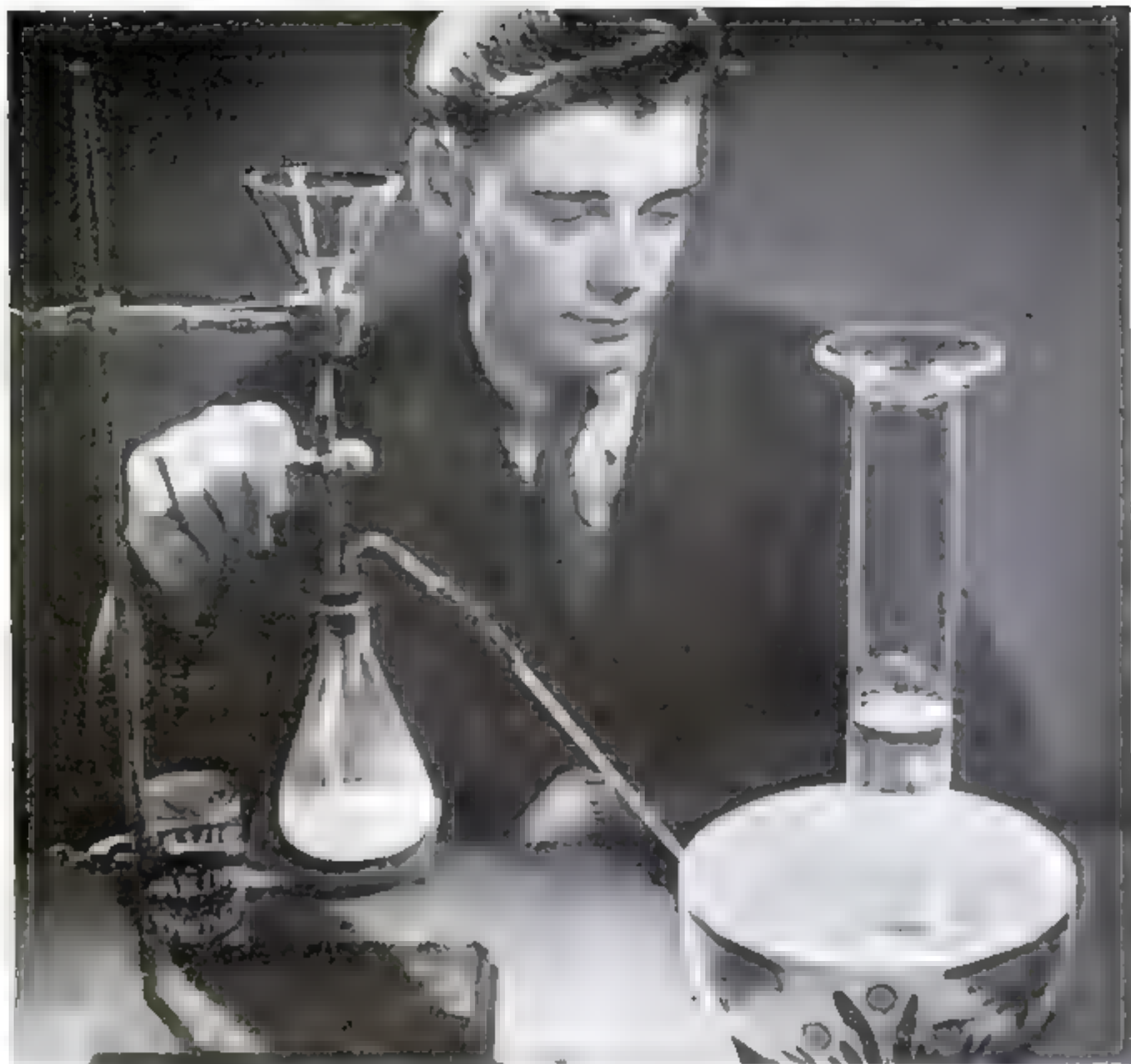


TRAPPING A REFLECTION in a tumbler or transparent box is a stunt that you can stage with a pane of plain glass used as a reflector. The result will be like that in the photo at the right. Stand the doll in the position shown in the diagram below, and darken the room and light the doll with a spotlight or lamp to get maximum reflection. Then, while you are in the position of the observer, reach behind the glass and move an inverted tumbler until the image appears to be in it. Measured, the distances from the center of the tumbler to the glass and from the doll to the glass will be exactly the same no matter where you place the doll.



JUNE, 1944





Testing Household Products

SIMPLE HOME EXPERIMENTS TELL MUCH ABOUT EVERYDAY ITEMS

By Kenneth M. Swezey

WITH prepared foods, medicines, cosmetics, cleaning preparations, and other household products purer and more consistent in quality now than a dozen years ago, thanks go to a vast army of chemists working behind the scenes. Chemists employed by the manufacturers check products constantly for purity and uniformity. Chemists of the Federal Government double-check to protect the public from harm and misinformation.

Using common items in your pantry, laundry, and medicine cabinet, you can

duplicate many of these tests. Dozens of ordinary household products, such as baking powder, ammonia, beauty preparations, ice cream, soft drinks, tea, coffee, and hydrogen peroxide, are chemical compounds whose mysteries you can probe in your home lab.

Baking powder—always a mixture of at least two chemical compounds—makes an interesting start. Its effectiveness in raising cake and biscuits lies in its ability to liberate carbon dioxide gas. According to Government standards, baking powder must give

off at least 12 percent of its weight as available carbon dioxide. You can check your favorite baking powder with a simple test.

Set up your apparatus as shown in the photo on the facing page. A tube to the bottom of a small Erlenmeyer flask is connected with a funnel above it by means of a rubber tube provided with a pinchcock. A bent delivery tube leads from the flask to the mouth of an inverted cylinder, which is supported just under the surface of water in a bowl by a cutaway tin can having a hole in its bottom. Fill the cylinder completely with the water at the start.

Put exactly 2 grams of the baking powder to be tested into the flask, insert the stopper, and close the pinchcock. Now measure out 50 ml. water and fill the funnel. Make sure there are no air bubbles in the stem of the funnel; then open the pinchcock, allow all the water to run into the flask, close the pinchcock quickly, and shake the flask gently for about a minute. Carbon dioxide gas will bubble up into the cylinder. If the cylinder is graduated, the volume of gas can be observed directly; if it is not, you may calculate the volume by simple geometry. After deducting 50 ml. from this volume to allow for the air forced out of the flask by the water, multiply the remainder by .002, which is the approximate weight, in grams, of 1 ml. carbon dioxide. From this you can easily calculate the percentage of gas liberated by the baking powder.

One ingredient of all baking powders is bicarbonate of soda. The others are compounds that form acids in the presence of water. The commonest of the acid-forming substances are tartrates (tartaric acid or potassium acid tartrate), phosphates (cal-

cium phosphate), and alum (sodium aluminum sulphate). A few laking powders contain all three, others contain one or two. To find out which your brand has, stir 10 grams baking powder in 50 ml. water until foaming has stopped. Then filter and test the filtrate.

For alum, put a little of the filtrate in a test tube and add a few drops of a solution of barium chloride. A white precipitate, which will not dissolve when dilute hydrochloric acid is added, is a sure sign of the presence of a sulphate such as soda alum or sodium aluminum sulphate.

Acidify another portion of the filtrate with a few drops of nitric acid. Warm this mixture and add it to 5 ml. ammonium molybdate solution. A bright yellow precipitate denotes a phosphate. Phosphates in other common substances such as tri sodium phosphate cleansers and soft drinks can be tested by the same method. The bright precipitate is sometimes used as a pigment.

To test for tartrates, pour a few milliliters of the filtrate into an evaporating dish, add several drops of concentrated sulphuric acid, and evaporate completely over a small flame. If tartrates are present, the residue will be charred and give off the odor of burnt sugar.

You can find the relative strength of two samples of household ammonia—which is really a solution of ammonia gas in water—by means of titration. Pour 5 ml. of each solution to be tested into separate test tubes, and add a drop of phenolphthalein solution to each to turn it pink. Now make a solution of 1 part sulphuric acid and 4 parts water. CAUTION! Always add the acid

HOUSEHOLD AMMONIA is turned pink by a drop of phenolphthalein solution. Sulphuric acid is added in counted drops. The number required to clear each of two samples shows relative strength

SAMPLES OF TEA are taken after steeping one, two, three, and four minutes. Iron chloride is added to precipitate iron tannate and to show more tannic acid present the longer the tea brews





PHOSPHATES OR PHOSPHORIC ACID in cleansers, baking powders, and soft drinks can be indicated by adding nitric acid and then ammonium molybdate. Phosphates form a yellow precipitate

to water, not the reverse! Add this drop by drop to each sample, agitating the tube as you do so, until the solution just turns white again. The number of drops required to neutralize each sample indicates the relative strength of the ammonia. Use only clear ammonia in this test, as the cloudy variety contains soap and other misleading ingredients.

Peroxide is also a solution—hydrogen peroxide in water—and if not tightly stoppered, the hydrogen peroxide may break up into oxygen and water and be worthless. To test a questionable sample, add several drops of dilute hydrochloric acid, and then add a little dilute solution of potassium bichromate. If hydrogen peroxide is present, a blue color will develop. This usually fades quickly, but a little ether shaken in will dissolve the blue solution and form a stable layer on top.

Gelatin is rarely, if ever, added to milk nowadays to give it body, but a frequent legitimate use is in ice cream where it increases smoothness. To test for it, make a solution of acid mercuric nitrate by dissolving a little mercury in twice its weight



GELATIN is easily detected in ice cream by adding acid mercuric nitrate solution and letting the sample stand a few minutes before filtering. Cloudiness in the filtrate will indicate gelatin

of concentrated nitric acid and diluting the resulting solution with 10 times its volume of distilled water. Add to 10 ml. melted ice cream 20 ml. mercuric nitrate solution and 40 ml. water. Let stand for a few minutes and then filter. Gelatin makes the filtrate slightly cloudy.

That continued brewing increases the tannic acid in tea can be demonstrated with samples brewed for one, two, three, and four minutes. To each add iron chloride solution drop by drop until no more iron tannate precipitate forms. Now shake the tubes. Each successive brew will be darker, indicating more tannic acid.

The presence of boron in tooth powder, borax, and boric acid is demonstrated by covering a sample with a few milliliters of denatured alcohol in a setup arranged as in the photo at the left. Add several drops of strong sulphuric acid to act as a catalyst. Upon boiling, a volatile ester is formed, the vapor from which pours from the upper glass tube. Lighted with a match, this vapor burns with a green flame, indicating that there is boron in the sample.

BORON in borax and boric acid is shown by adding alcohol and sulphuric acid. Vapor from a volatile ester formed will burn



You'll Like the Road Ahead

(Continued from page 79)

This last plan sounds inviting, but it overlooks the major cause and objective of most driving—cities. In a report made in 1939, the Bureau of Public Roads junked this cross-continental scheme and produced the germ of the present interregional plan. The report also presented some rather startling facts. Transcontinental traffic reaches barely 300 cars a day. Eighty-five percent of all car trips are under 30 miles. Ninety percent of all traffic found on main highways starts or ends in cities. The nearer you get to a city, the more congested the traffic becomes. These findings cried out for a network of intercity roads, with frequent access points near the cities for short-run traffic, service roads within city limits, and by-passing or "through" roads for long-distance traffic. This is precisely what the interregional roads will provide—and with amazing efficiency.

These motorways will reach—and relieve—more than half of our cities with populations of 10,000 or more. In addition, they will serve industrial centers and military and naval bases. Their routes seem nearly perfect.

Their design is perhaps more of a compromise between dreams and existing fact. The roads will be expressways, on the model of Germany's *Autobahnen* and England's proposed motorways—free of crossings, with occasional access through smooth-running interchanges. Interregional roads carrying over 5,000 cars a day will have no crossroads, while branches with less traffic may be allowed occasional crossings if provisions are made eventually to scrap them. Access to the first two types of roads will probably be by cloverleaf interchanges, or some variation of this type of intersection. Where it isn't worth while to build an intersection, an interregional road will be depressed to pass beneath a crossroad.

So far, this checks with futuristic ideals—except in one part. Disciples of Norman Bel Geddes argue that the cloverleaf is expensive and complex, and suggest instead long, gently curving ramps to ease traffic onto crossroads. Although possibly superior, this would involve highways of 16 lanes or more, which are out of the picture now.

The second shibboleth of a good motorway is the separation of traffic. Again compromising, separate one-way roads are specified wherever possible. Where they can't be laid, median strips must be installed—four feet wide on urban highways, 15 feet wide on rural roads. In emergency cases, undivided two-lane roads will be allowed to

stand, if they are designed so that ultimately they can be widened. Generally, this is the provision for the "hardship cases." Four and six lanes are suggested for light and heavier-traveled sections respectively.

Curves are to be kept to a high of nine degrees on slow stretches of road, with stricter standards elsewhere, and all curves over one degree will be banked. Road edges will be gently sloped upward, where possible, or faced with a retaining wall. Long sight distances are also specified. All calculations are based on minimum speeds of 75 m.p.h. in the country, and 50 m.p.h. on roads leading through or past cities.

These are sensible outlines. By leaving the driver with a limited number of problems and decisions (the cloverleaf, city-service roads, wide dividers, all limit initiative and possible error), they approach the ideal of "the road that drives the car."

But automatic street lighting that flashes on only when a car nears, automatic "dimmers" that lower headlight beams as a car approaches head-on, electronically controlled lane barriers to keep cars from snaking in and out until it's safe to do so, adjustable traffic lights that switch red and green to suit the needs of passing traffic, 64-lane highways with slow, leisurely, fast, express, and truck lanes—all these must wait; some until our cities and towns themselves are rebuilt, others until the public is convinced that driving can be a robotlike job.

When Congress votes funds for state purchases of rights-of-way, interregional roads will be on their first legs. The tremendous job of rebuilding our highways will finally be done according to plan—and not by fits and starts, as it has been for so long. But besides this, there'll be a lot of other road work to catch up on. Repair work, for instance. Small roads have done mighty jobs during these war years without a touch of face lifting. Estimates indicate that repairs are needed on as much as 150,000 miles of state roads alone. This was up to only last January and doesn't include city streets, which have taken a heavy pounding from wartime traffic.

Aside from this, increased air traffic will need land routes as well—flight strips, or paved runways, up to 5,000 feet long, joining or intersecting highways, and intended as refueling or "whistle-stop" stations for passenger planes; and also access roads from airfields to industrial centers, to service the cargo traffic that most certainly will boom when transport planes begin to fly on daily schedules.

Laying Tracks in the Sky

(Continued from page 133)

the Nazis then bombed empty fields, because the intersection of the new beam with their beams fooled them. Maj. W. G. McConnel, who directs AACS range work, grins when he recalls this yarn and remarks that there's more than one way to skin a cat. His men have highly mobile ranges, and new tricks in their blueprints.

On a modern American airway, invisible signal cones and other special warning waves, which flash a light in the plane's cockpit when it passes directly over certain points, also mark routes for airmen. These devices, too, have been installed around the world.

In addition to guiding planes through the heavens and locating them in emergencies, the AACS must get them into and out of the sky safely at terminals. Its tower-control men are the M. P.'s of the air over ports. They must know and anticipate the performance of great numbers of all kinds of planes. And even at spots you may never have heard of, some of these tower-control men now are as busy as the traffic cops in Times Square on election nights.

Not long ago a cadet, while soloing, suddenly went blind, presumably because of nervous tension. Nevertheless, the tower man told him what to do, and he landed without mishap. Men blinded by oil spurt-ing from broken lines, men injured in combat, or flying crippled, difficult-to-control planes, have been brought to earth safely many times, thanks to the tower men. The ability to "talk 'em in" is part of their stock in trade.

Maj. Clarence Lang, an air-mail pioneer who knows the perils of flying by the seat of one's pants—and who now has a son in the Army Air Forces, directs the AACS blind-landing work. Apparatus not only to bring the pilot into a direct line with the runway, but also to bring him down the correct glide path, has been so perfected that a pilot can learn his part of the trick in about 10 hours. Major Lang also has a "baby localizer" for use at hastily constructed airports; it can be flown anywhere and set up within half an hour.

Although AACS stations average more than 2,000 airplane contacts per hour, this is only part of their job. Communications between ground stations regarding plane movements, weather, contacts with the enemy, and so on, are also essential to safe, busy, global skyways.

For this work, 25,000 miles of wire circuits and radio circuits more than 20 times

that long are used. The AACS has 250 hand-keyed stations handling 4,000,000 words a month, a fraction of the millions handled daily by all methods. On busy circuits, it uses radio-teletypes and automatic senders that can be sped up to 250 words a minute. A message can be radio-teletyped around the world now, and automatic high-speed circuits extend much farther.

The Army Air Forces Weather Service is the biggest single user of these lines. Its personnel has increased 9,000 percent in two years, and it now makes thousands of forecasts a month for areas in which scarcely any forecasts were available before the war. Since the atmosphere circulates around the world in broader and deeper streams than the Gulf Stream or the Japanese Current, and is far more tricky, especially near the equator, the weathermen need a communications system that is both immense and fast. Since the Germans and Japs also know a lot about the weather, the value of our forecasts depends largely on the speed with which they are transmitted, and it's up to the AACS to provide this speed. In addition to code reports, it now transmits facsimile weather maps in some areas.

Having been built for war rather than commerce, this gigantic, high-speed system has been made highly flexible. This means that it can be adapted readily to peacetime purposes. It will be even faster when the need for concealing as well as conveying war information ends. By then, too, the AACS will have accustomed the whole world's flyers to American methods.

To bring the date when **POPULAR SCIENCE MONTHLY** goes on sale closer to the date on the cover of the magazine, the July 1944 issue will be published on June 9, the August issue on July 19, and the September issue on August 30. Thereafter, each issue will be published on or about the first of the month that is shown on the cover.

Subscribers will not lose by this adjustment of our publication date, as each will receive the full number of issues to which his subscription entitles him.

A Fort Lives to Fight Again

(Continued from page 99.)

You would think this would give him a lot of satisfaction. But the war to him is far more personal than that. Despite all the bloodthirsty talk of some generals, the Lieutenant is the only American I have met in this theater who seems consumed with the desire to kill Germans, personally. He wants to be an aerial gunner in a Fortress, to sit behind a gun and shoot; he has a stack of letters so high on the subject, capped with a disapproval by order of the Commanding General himself. Hence the frustration. He wants to fight Germans and they won't let him. Why, dammit, you might think his life was valuable!

The Lieutenant came from Norway 20 years ago. Some of his family may still be alive there, under the terroristic heel of the Nazis. That is why we don't use his name, why he feels such a mood of vengeance. I have been tempted to write this whole piece about him, because he typifies the fact that most men in uniform want to get to the scene of action, while relatively few out of all the millions will ever be on the first fighting team—and many of these are far more valuable where they are.

Be that as it may, I wouldn't bet against the Lieutenant. He went into the Army as a private, rather than as an officer, so that age would not stand in his way; and he has come a long distance since. There is going to be a lot of shooting in this war and, Commanding General or not, the Lieutenant means to do his share of it.

Master Sergeant Joe Wilderman, who works with the Lieutenant as actual supervisor of the units in the field, takes things more philosophically, as an old dogface with 20 years of service is likely to do. Joe has seen his share of this war's killing. The President himself signed a permanent warrant for Joe, in recognition of the sinking of a Japanese submarine.

As a bombardier, Joe flew in Fortresses in mid-Pacific from Pearl Harbor until the Battle of Midway. Then for five months he was based on Fiji. He bombed Guadalcanal. Back in those days, Fortress service was not figured in missions. It was mostly search, it's true, but you got one day off in 10, flew 250 to 300 hours a month. Service like that takes it out of a man. Joe's hand is shaky when he lights a cigarette, but it's still good for steadying the jumpy wheel of a jeep.

Joe spends most of his time that way now. He lives in an ancient public house, where Dickens did a lot of his writing, and picks his way around through the breathlessly beautiful jigsaw puzzle of England's back-

country roads—seeing to it that the mobile crews get on with their job.

Joe turned up in the ETO early in 1943, and his first job was to establish a salvage yard. Out in the South Pacific they had to learn this sort of thing the hard way. Joe has seen the time when they had to put the remnants of three planes together to get one that would fly. Here the job had to be done quickly and in a big way, the scale of operations was increasing so fast. It is startling to think of such precious things as heavy bombers being treated like the wrecks in a small-town automobile graveyard, where country folks go to get spare parts for their jallopies. But that's what it amounts to.

Once the salvage yard was going, the mobile-unit outfit grabbed Joe. So here we have an old hard-boiled top kick, who for 20 years has dealt with military aircraft and Army men, on and off the ground; and his assignment is riding herd on a lot of green kids with a big job. You'd be surprised at what he thinks of it all. He makes his rounds in a state of continual amazement—these kids are so wonderful.

The Army has a paternalistic tradition. An officer looks out for his men, sees that they are properly clothed, fed, and bedded down. He gives them leave and liberty at his discretion, maintains discipline on and off the post. But these mobile units, under kid sergeants, a lot of mine-run American kids, most of them away from home for the first time, are completely on their own in a strange country. They sign their own passes, and can go out every night if they want to. They eat and sleep as they can, rustling for whatever an unfamiliar rural countryside affords. They work in the cold rain and fog and mud, away from all doctors and dieticians. And, says Joe, their health record is far better than that of the Army as a whole; their conduct record is practically perfect; they eat well and sleep well, they get along fine with the country folks, they are having a swell time. And they are getting the work out. To an old Army man it's amazing, and Joe never gets tired of boasting about it.

Take this crew that worked on the *Sir Baboon McGoon*. This was a small detachment of only eight members, in charge of Sergeant Donnell J. Jones. Jonesy is 23 years old. He grew up on a Nebraska farm, then went to Pasadena, Calif., with his folks and graduated from Chino High School in 1939. For three semesters he worked his way at Pomona Junior College, getting up

at 4 a.m. to milk 15 cows by hand, then going back after classes to milk them again. That schedule was too tough, especially when war work came along, and Jones quit to go on the Lockheed assembly line. Right after Pearl Harbor he enlisted.

The *Baboon* was the fifty-sixth job Jonesy worked on in a year, and the first one where he had full charge. Most of the crew were fresh from the States, on the job only a month. A number of them had been trained together at an Army school in Rome, N. Y. Here they are: Staff Sergeant Steve M. Csakany, of South Bend, Ind.; Private first class Denis Maloney, of Brooklyn, N. Y.; Private Daniel Rosenblatt, of Brooklyn; Private Bernard P. Bajardi, of Ozone Park, L. I.; ex-Corporal Hal Israel, of New York City; Private first class Donald Wolf, of Cleveland, Ohio, and Private Hank Green, of Bridgeport, Conn.

Hank Green is the outfit's B. T. O. Before he got a letter from the President, Hank ran a restaurant, and as Big Time Operator it was his job to rustle eggs and chickens from the countryside. But on this job he

soon was practically out of work, for within the limitations of a strictly rationed country the butcher, the baker, the candlestick maker were soon seeing to it that these kids lived on the fat of the land.

Near the *Baboon's* resting place is a picturesque town of 1,300 inhabitants, dominated by one of England's ancient castles. On the grounds the boys found sleeping quarters in a modern bungalow, while for meals they jeeped and trucked to an old public house known as the Crown.

There is no spit and polish about this outfit. They are dungaree soldiers, and working on the *Baboon* was a mud-monkey's job, as trucks and continued rainfall turned the land around it into a slough. They were not self-conscious, and the streets and old town square rang with unaccustomed shouts, laughter, and monkeyshines. But young and old, the local folks seemed to love them—especially the elderly proprietor of the Crown, who wrote letters to their parents telling what fine boys they were and who hopes to visit them in America when peacetime comes.

Coming — a Better Life

(Continued from page 72)

tory all-around fuel. The Army has seen to that, because it had to have, and got, gasoline that was as good in winter as in summer, and didn't deteriorate during long storage. This will probably be standard automobile fuel after the war. There may be something even better in the offing, but this is in use right now.

Even if you stay at home, you are going to have a better life, more comforts, more conveniences. You probably will have many of them in the home where you live now.

Air-conditioning will be widely used, with improvements that were worked out for war factories, precision-instrument plants, and special purposes as yet undisclosed. One of the foremost improvements will be the Precipitron, which strains dust and pollen from the air by passing it through an electric field.

For windows there will be plastic drapery fabrics which are flame-resistant and fade-proof. Similar fabrics will be used in upholstery and rugs. Moths won't touch such material. Dirt and stains can be wiped off with a damp cloth. They will wear much longer than natural fibers.

New plastics will be available for floors and walls, in many colors and designs. Plasticized woods, developed for light boats and airplanes, can be used for finish or for furniture.

Lighting will be vastly improved, not

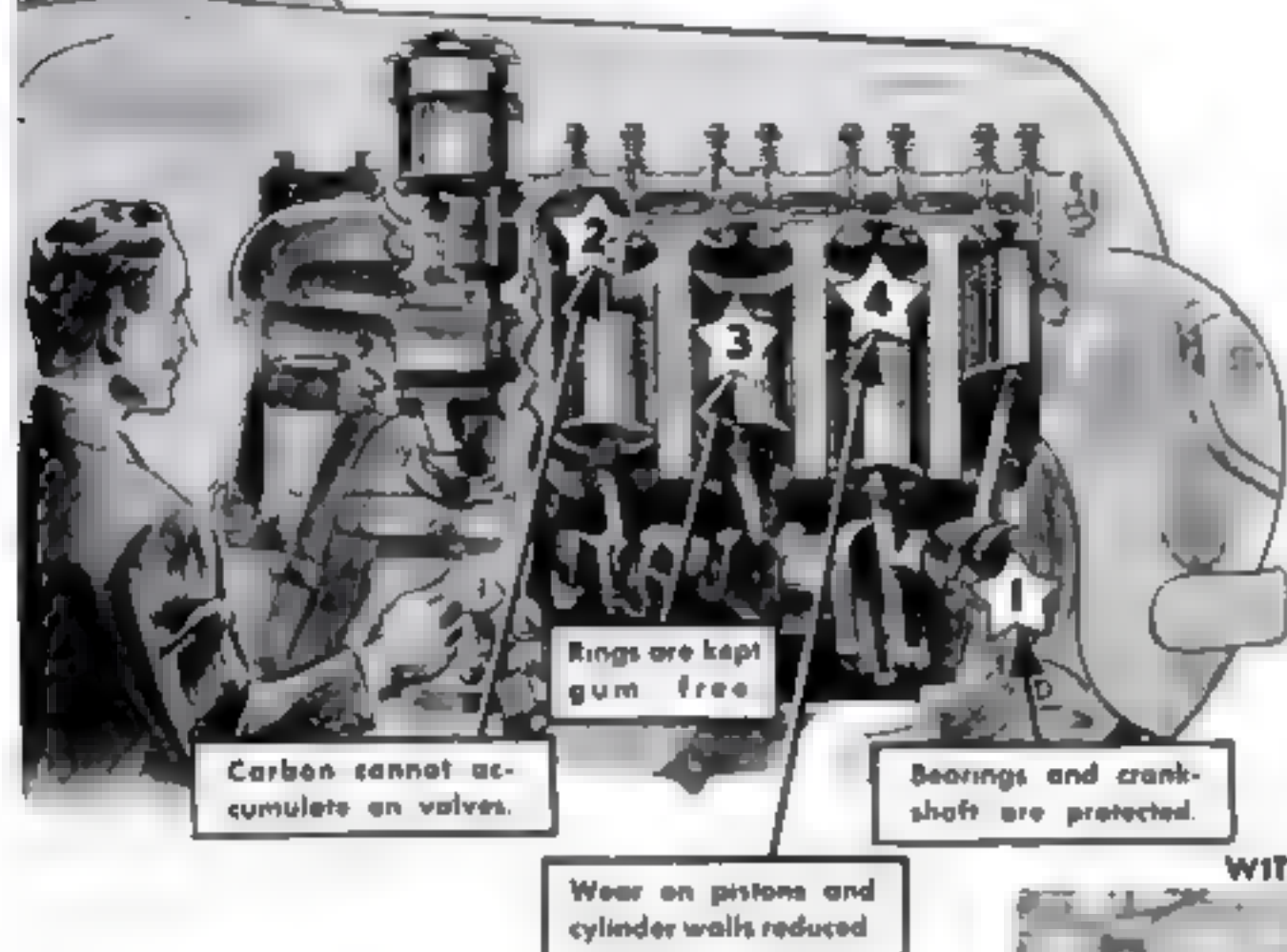
only in efficiency and design but in installation. Plastics of the Lucite type will carry it wherever needed, around corners if necessary. Contrast painting, which has been so effective in improving light efficiency in factories and aboard warships, will be used in the home. Fluorescent lights will be available in new shapes and sizes (P.S.M., May '44, p. 108). New phosphor paints will be used on dark stairways and in back halls. Radiant-heat lamps may be used in bathrooms and closets.

Your present window screens can be sprayed with insecticides which will repel invaders for months at a time. If you prefer, you can have screens made of plastic wire, and permanently colored to match or contrast with your house. Such screens will never rust or corrode.

In your kitchen or pantry you probably will have one of the compact quick-freezing units; if you live in the country, you will have a larger type in which to store the summer harvest from your garden. Condensed foods will conserve closet and pantry space in apartments.

This is just a sampling of things ahead—not things to come, but developments and changes already here, working, in use. Today they are doing war jobs, making life easier, simpler, more efficient for those who are manning the guns. Tomorrow they will be available to all of us.

THE OILY OIL THAT STOPS CORROSION



HOW PYROIL PROTECTS

WITHOUT PYROIL

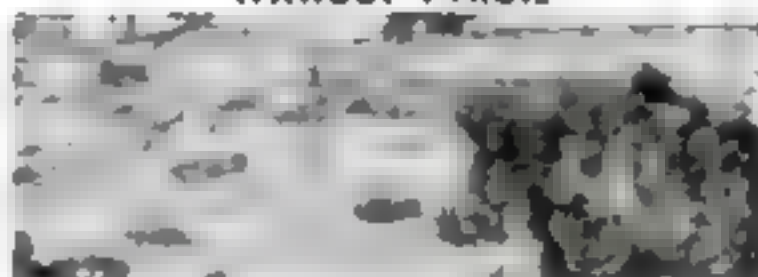


Fig. 1 Section of Alloy bearing lubricated with good quality Pennsylvania oil only. Note chemical and mechanical attack.

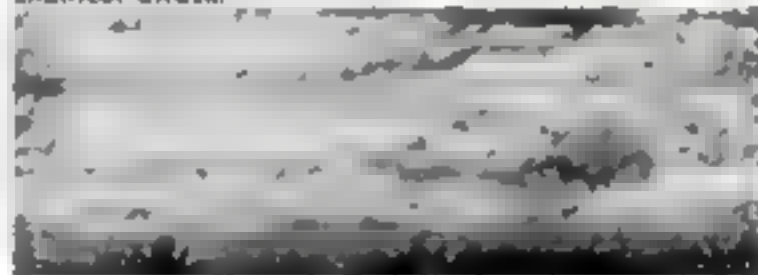


Fig. 2 Section of shaft from test with bearing shown in Fig. 1. Note the inclusions of corroded bearing metal.

WITH PYROIL



Fig. 3. Section of bearing lubricated with some Pennsylvania oil as Figs. 1 and 2, but with Pyroil B added. It is to be observed that corrosion is negligible and that the bearing is free from mechanical attack.



Fig. 4. Section of shaft from test with bearing shown in Fig. 3 (Pyroil used). It is to be observed that there is a practical absence of bearing metal and negligible corrosion. Pyroil reduces metal to metal contact and inhibits corrosion.

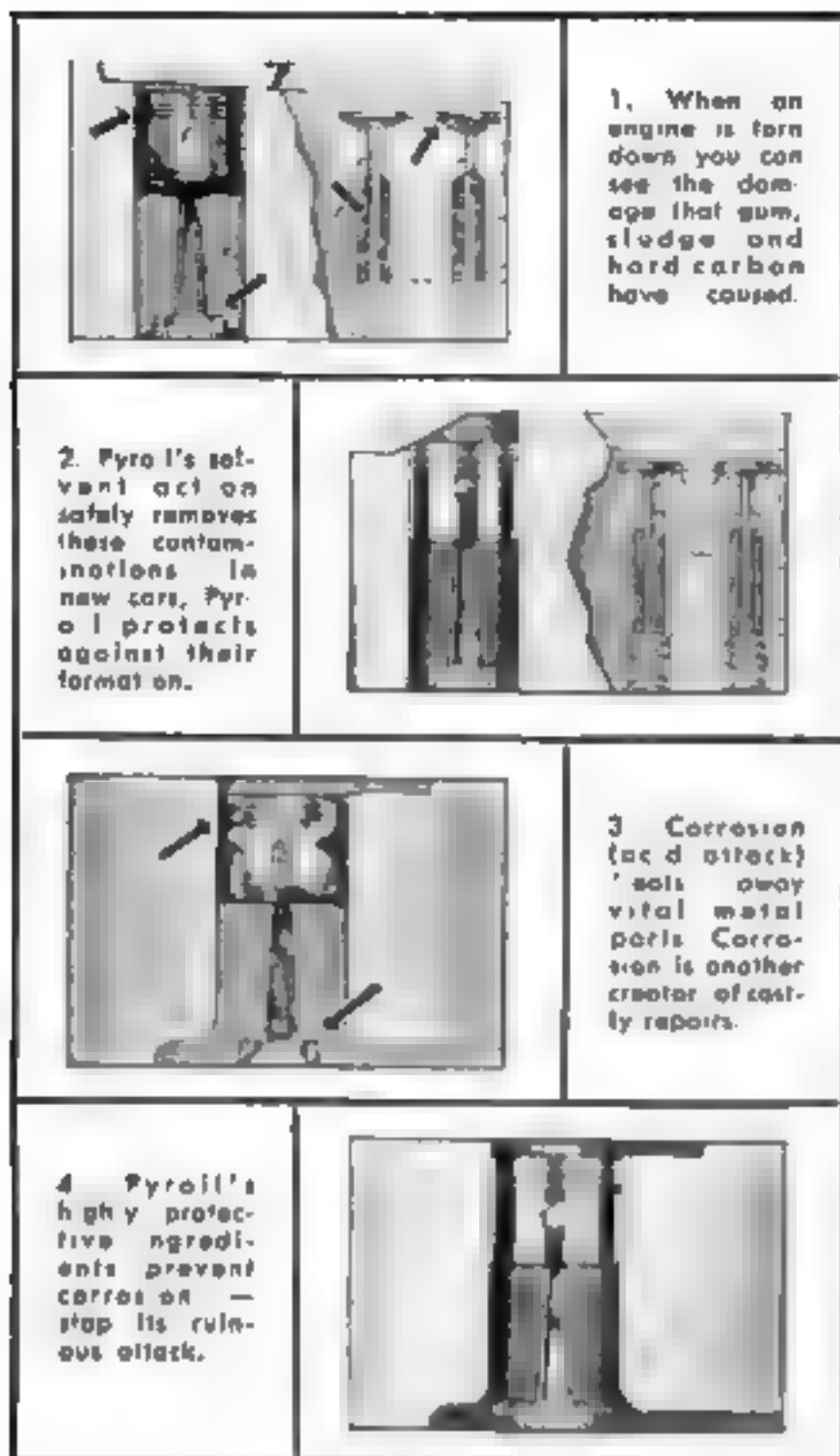
REMEMBER the ads that used to show a razor blade's edge under a super-microscope? Remember the jagged edges and how you said to yourself, "No wonder my face feels as though somebody had gone over it with a spike-tooth harrow"?

If the edge of a razor blade or a surgeon's knife looks like that under the microscope, how do you suppose the side of a piston or a cylinder wall, no matter how carefully machined, ground, or lapped, looks under the instrument?

You're right. It does! It has more holes and valleys and ridges and peaks and sharp points and jagged edges than you can shake a stick at. And that's nothing against the razor blade maker or automobile manufacturer or the piston maker. They did their best. They got as sharp an edge or smooth a surface on them as it was humanly possible to get, but they were working with materials that would go so far and no farther in the achieving of the perfectly smooth or the perfectly fitted. You can't blame the man for the limitations of the materials.

What do you suppose happens when two surfaces, full of these jagged microscopic hills and dales, spears and notches, are fitted tightly together and forced to rub against each other at high speed?

They scrape and wear, of course. They get hot and they corrode. If you were to continue to rub the parts against each other at high



speed, it wouldn't be long before they would swell from the heat and stick tight. That is known as "seizing," or more commonly among mechanics, "freezing."

Of course, no one operates metal parts tight against each other in any such way without a lubricant. It is the lubricant, oil in the case of the automobile engine, that steps in and fills up all those microscopic valleys and wedges to the top of the hills and spearpoints. That process reduces friction and heating. It allows the metal parts to slide one against the other with a thin film of slickness between.

But oil alone will wipe off, scrape off, wash off, in an automobile engine, with the unmixed and unburned gasoline that gets by the piston rings. At high temperatures, oil alone will break up, combine with the slight amounts of water that condense in combustion, and form sludge. Oil alone will heat and form "varnishes" that stick to the cylinder and piston walls and add a whole new friction load that may become even heavier than

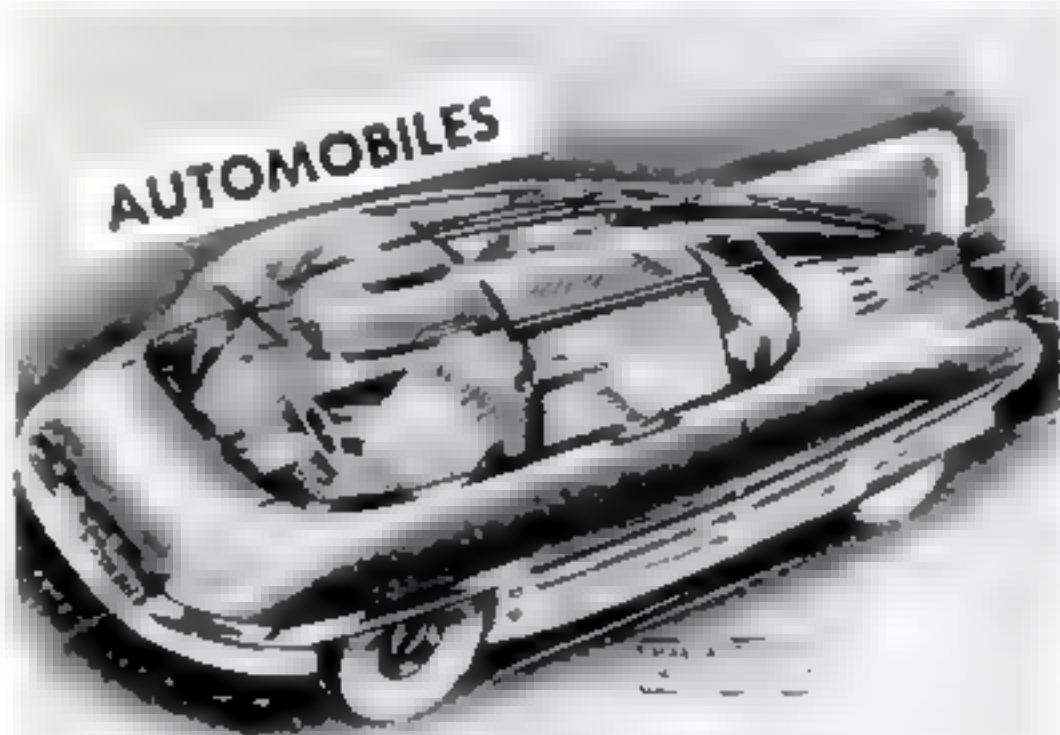
the first tightness of new metal against new metal. Some oils even contain materials that will attack the metal surfaces and corrode them.

Pure oil, as any chemist knows, is a mixture of organic compound, hydrocarbons—that is, it contains none of what are commonly called the "metallic" elements. Now, if you were able to extract from oil its basic essence, the quality that makes it slick, that allows it to keep down friction; in other words, concentrate its lubricating qualities, you'd really have something, wouldn't you?

That's what the Pyroil people of LaCrosse, Wis., did. They found a method by which they could take the basic qualities of the best Pennsylvania oils and, by exacting processes, separate them out and re-form them into a new concentrated solution that could be placed in any lubricating oil to make it slicker and more penetrating, more heat resistant, and they found, when they were through, that it halted corrosion, as well!

Pyroil-treated oil adheres to a cylinder or piston wall like a leech. It won't wipe off. It won't wash off with any solvent that ever gets into a motor car engine. Added to the fuel itself, it condenses in a fine spray right in the combustion chamber and lubricates top piston rings, the ones that normally get the most wear. It keeps valves from sticking. Included in its formula are substances that dissolve the "binders" that let carbon stick to cylinder heads and valve faces. The carbon comes loose and is blown out the exhaust.

Crank bearings of the modern motor car usually are made of a silver-cadmium alloy or a copper-lead mixture. The use of these metals allows extremely close fits, impossible with the older type of babbitt bearings. They are fitted so closely, that it requires a much lighter grade of oil than used to be common to get between their surfaces.



By the addition of Pyroil, the regular engine lubricant is given the new quality of spreading thinner and farther—what physicists know as lowered interfacial tension. Thus it is able to get into these exceedingly fine clearances and form a protective film there more readily, more quickly, and at much lower temperatures than untreated oil of the finest grade.

Pyroil, when added to the lubricating oil, multiplies the "slickness," the lubricating quality, of that oil many-fold. That action saves friction, heat, and power. When you add to that quality its ability to penetrate and stay in spite of the action of any solvents present, you have the two fundamental facts that make Pyroil of greatest

importance in any lubrication problem.

Because Pyroil endows the lubricant with which it is mixed with the ability to creep into exceedingly small spaces—and stay there, it is always present as a film between bearing and shaft when the engine is started even after standing for a long period. Most of the wear in bearings and tightly fitted reciprocating parts in an automobile engine occurs in starting. No matter how much pressure you put on the lubricating oil by pump, no matter how many conduits you provide for the oil to reach the part that needs lubricating, the speed of the flow is limited by the viscosity of the oil itself.

With Pyroil in the lubricant, the oil is already there when the engine is started.

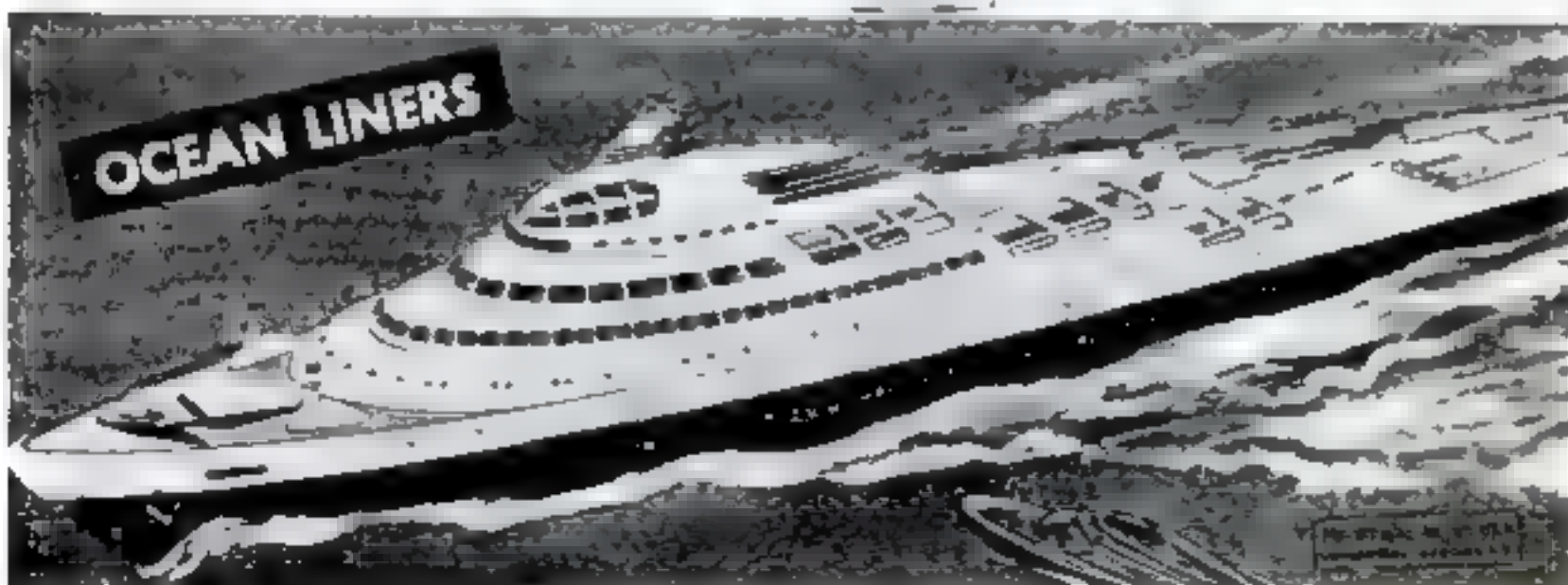
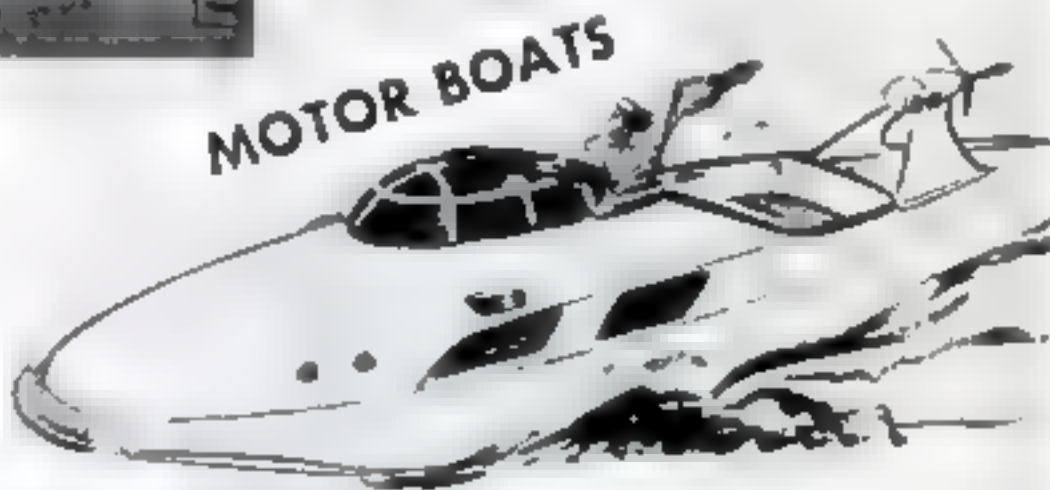
So there's time to wait for the new supply without excessive wear taking place in the meantime.

As indicated, Pyroil, is made in two types, one to be added to the lubricant, the other to the fuel. While the second serves its particular purpose in lubricating top cylinder parts that normally receive no oil in an internal combustion engine, its action against carbon and its anti-corrosive properties are equally important. Most fuels are "treated" with antiknock properties. Corrosion inhibitors are especially important when these are used.

Many damage dangers that are inherent in machine and especially in-



Automobiles, motorboats, airplanes, and helicopters—anything powered by internal combustion engines—need Pyroil. Even ships and heavy machinery find it necessary to prevent excess wear.





Rear Admiral
Richard E. Byrd

Admiral Byrd took a large supply of Pyroil on his third expedition to the south polar regions.



WILBUR SHAW, Auto Racer
"Pyroil was a great help in my fuel to win first place in the 1940 Indianapolis 500 mile auto race," says Wilbur Shaw, three-time winner of that event.

Sir Malcolm Campbell
and his Bluebird Racer
Pyroil went along and helped make possible the 300 miles per hour speed record set by Sir Malcolm Campbell.



ternal combustion engine design can be guarded against and even overcome by the use of this super-slick oil.

It unquestionably reduces wear on moving metal parts—thousands of laboratory and field tests under careful control by outstanding authorities attest it. It reduces friction and heating. It removes carbon and inhibits its formation. It increases the film strength of the oil with which it is mixed. It halts or inhibits corrosion and the forms of chemical attack that are met in any of the common applications.

It will increase power or reduce fuel consumption, as you please; it adds to the life of the parts; it makes operation smoother and quieter, adds mileage to autos and years to machines; it cuts costs and repairs.

Its use in new engines and machines is recommended by engineers, but it is not a "break-in" oil. Too many of these in the past have contained abrasives. They "smoothed" the operation of bearings and platons, valves and pins too often by wearing them to a fit. This is not the action of Pyroil. There are no abrasives, no acids, no metallic soaps in it.

Nor is Pyroil a substitute for regular motor oil. It is a highly concentrated super-lubricant to be added to the regular oil or fuel or grease in small amounts. It reaches tighter bearing surfaces quicker and it stays there. Its constant use in the lubricant insures that it will be there at all times, regardless of temperature.

Another point of importance to the modern automobile operator is Pyroil's ability not only to prevent the deposition of varnish, but also to keep the sludges constantly in suspension. Pyroil contains elements that prevent sludge from settling and sticking. This means when you flush the crankcase and change oil, all of the sludge and

old oil comes out. You don't add new oil to old sludge when you use Pyroil.

Pyroil, which was first introduced to help the owner of an automobile solve some of the problems the machinists and designers could not be expected to solve metallurgically, has won such wide acceptance that its use has spread far beyond its original field. Wherever there is a bearing, a surface where metal touches metal, where oil or grease is used as a lubricant, there you find Pyroil or a need for it. And it does its job, stays there, keeps its qualities whether it operates at low or elevated temperatures.

Just as a sample, here are a few of many other worldwide Pyroil applications: Machinery of all kinds; air cleaners, flour and feed mills, drill presses; all sorts of electric motors, generators, and similar equipment; high speed grinders, line shaft bearings, rollers, conveyors, fans, compressors; farm equipment, elevators; steam, gasoline, and Diesel powerplants; turbines, pumps, journal boxes; transmissions of all sorts; milk plants, cotton gins, match plants; newspapers, paper mills, printing plants; electric street cars, electric and gasoline buses; fire departments, water departments; and mining machinery and dredges; watches and clocks, guns, fishing reels; electric shavers.

Want some figures? The Pyroil company has 'em by the book and the score. But here are a few: Fuel consumption savings in auto engines, 11.5%. Horsepower is often appreciably increased, mechanical efficiency up 7%; reduction in friction loss, 46.6%; length of life—doubled! Address your request for literature and other startling information to Pyroil Company, 907 Main St., LaCrosse, Wisconsin.

Horsepower and efficiency go up—costs and repairs come down. That's the story of Pyroil.

ADV.

POPULAR SCIENCE



Explorer in Microchemistry

The Story of Herman Liebhafsky

Explorers usually go a-hunting with tents, guns, cameras, and the like, but Dr. Herman Liebhafsky, a chemist in G.E.'s Research Laboratory, uses microscope and test tubes for exploring equipment.

He's an explorer in the Lilliput land of microchemistry. He can weigh a piece of paper, have you write your name on it, put it on the scales



again—and tell you how much your signature weighs! His answer will be in gammas, and a gamma is $1/28,329,000$ of an ounce!

Herman Liebhafsky's first exploration was into America, for he came here from Austria-Hungary when he was six. He

knew no English when he started in school, in a wooden-frame schoolhouse in the farming country of South Central Texas. But in only three weeks, his teacher had him read a story before a woman's club. He went through it beautifully—but didn't understand a word he read!

In his knee-pants stage, Herman thought he wanted to be a farmer—before a cow picked him up on her horns one day and tossed him over the fence into his mother's arms—also before he just missed kneeling on a coiled rattlesnake while he was picking cotton!

Then, in high school, the unknown territory of science was opened to him, and he went to Texas A. and M. to study chemical engineering. After graduation, in order to explore further into the fundamentals of chemistry, he took post-graduate work at the University of Nebraska. From there he went to the University of California, where he received a Ph.D. and remained for five more years as an instructor in chemistry.

He then joined the staff of the G.E. Research Laboratory, worked with a consultant on chemical problems, and de-

vised special microchemical techniques to solve those problems. In many engineering developments, the only clue to vital information is a microscopic particle of matter. Microchemistry allows the scientist to analyze the particle as swiftly and accurately as though it were as large as a house.



Through his skill in exploring these tiny worlds, Herman Liebhafsky is helping solve the problems of giving our war machines the most efficient design, and our soldiers the most powerful weapons. General Electric Company, Schenectady, N. Y.

Hear the General Electric radio programs: "The G-E All-girl Orchestra" Sunday 10 p.m. EWT, NBC—"The World Today" news, every weekday 6:45 p.m. EWT, CBS.

The best investment in the world is in this country's future
Buy War Bonds and Stamps

GENERAL ELECTRIC

USA-112

Thousands of the men and women who build ships for Victory keep their spark plugs "on the job" longer with regular cleaning and adjustment. When replacement is necessary, they specify AC Spark Plugs for utmost reliability.



CLEAN SPARK
PLUGS SAVE UP
TO ONE GALLON
OF GAS IN TEN

SPARK PLUGS

BUY WAR BONDS AND BRING VICTORY QUICKER

No Helicopter Tomorrow

(Continued from page 61)

ly. If you want to move forward, you push lightly on a conventional control stick. Instead of actuating the elevator in the empennage, as in a conventional aircraft, the stick flattens the pitch of the rotor blades in their sweep through the forward quadrant of their circle, and increases the pitch in the rear quadrant. The pilot can fly in any direction he chooses, even backward, by moving the stick accordingly.

All this sounds relatively simple, and it raises the question why a good helicopter was so long in arriving. It isn't simple. The helicopter is the most complex flying machine that engineering ever has produced.

The matter of torque control has led engineers into all kinds of complex solutions. Anyone knows that whenever power is applied to a wheel, the object to which it is attached tends to counter-rotate. The fuselage of a helicopter wants to turn in the direction opposite to that of rotor rotation.

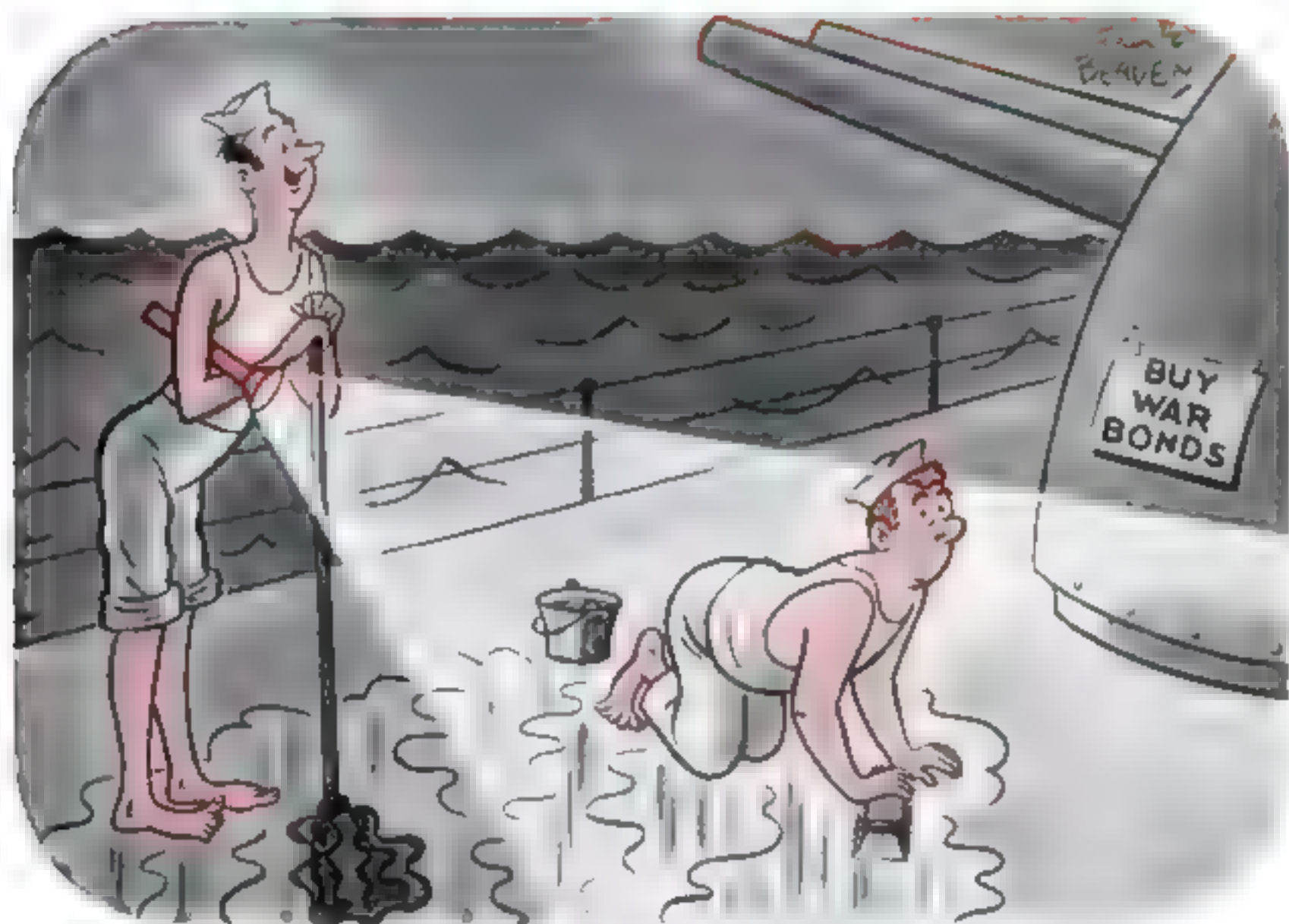
The Sikorsky helicopter, made in Bridgeport, Conn., and one known as the P-V—also notably successful—made in Philadelphia, overcome torque by the installation of a small, compensating rotor working in a vertical plane on the empennage. A few degrees of positive incidence as torque compensation is maintained on the small rotor—which, on the Sikorsky, measures 7.5 feet in diameter as compared with a diameter of 36 feet for the main rotor. By increasing and decreasing the pitch of the torque-compensating rotor, or reversing it completely, the pilot obtains full directional control. Less than 10 percent of the ship's power output is absorbed by the small rotor.

A second method of overcoming torque is the installation of balanced rotors turning in opposite directions, as in the Platt-LePage helicopter made at Eddystone, Pa., for the Army, and the Focke-Achgelis helicopter, produced in Germany before the war. Mounted on outriggers at the sides of the fuselage opposite the center of gravity, the rotors are driven by geared shafts. The Focke ship attains horizontal velocity through tiltable rotor heads and directional control by separately varying the lift of the rotors. A conventional rudder serves as an auxiliary directional control in forward flight. The balanced-rotor type of helicopter has a good deal of sheer mass.

A third method is installation of counter-rotating coaxial rotors, one above the other, as in the De Bothezat helicopter engineered in Long Island City, in the Breguet helicop-

(Continued on page 210)

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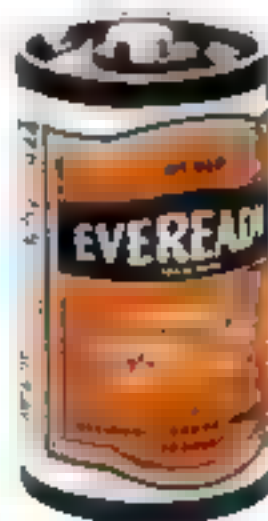


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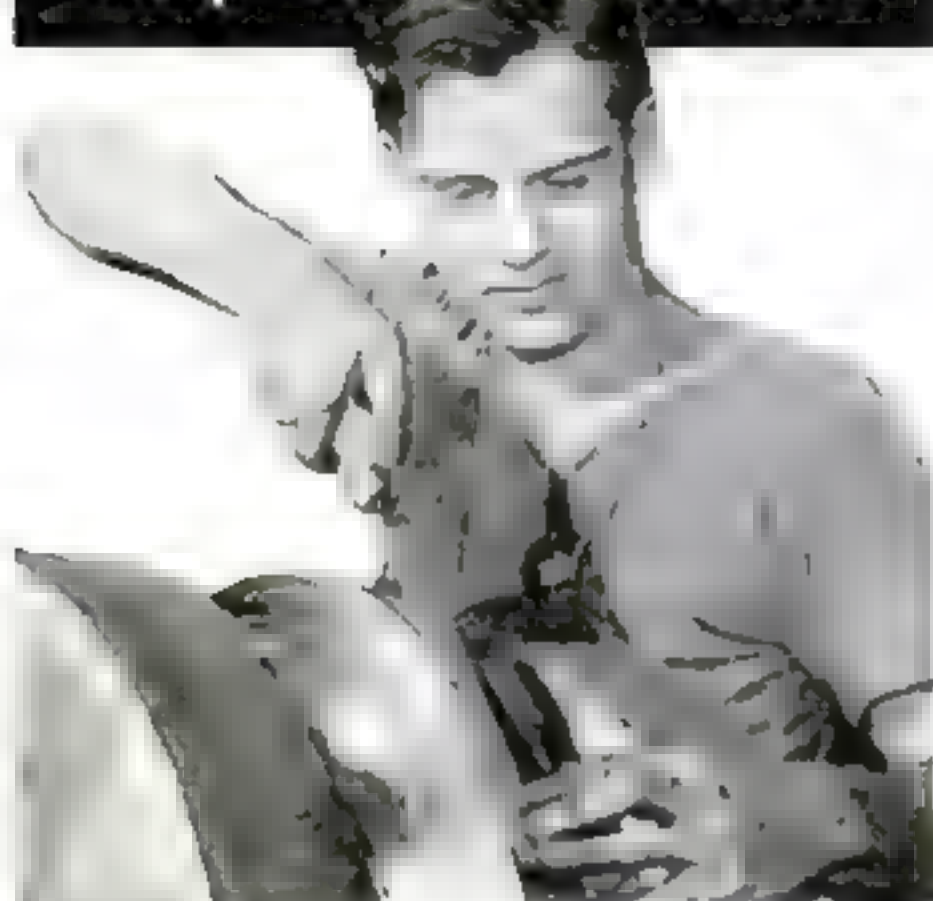
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No Helicopter Tomorrow

(Continued from page 206)

ter made by the veteran French aircraft manufacturer, and others. Of the three, the compensating-rotor type has been by far the most successful.

Notwithstanding the fact that from 75 to 100 helicopter projects are under way in the United States—perhaps a dozen have adequate funds for research behind them—the problems in direct-lift flight remaining for solution are prodigious. Vibration is an ever-present worry. In the hope of producing a helicopter that could be stored away in the garage, the Sikorsky organization experimented with a two-bladed rotor that could be lined up with the horizontal axis of the machine when it sat at rest. In that particular helicopter lateral vibration at a frequency of twice-per-rotor revolution developed.

The vibration produced by an awkward cross-wind landing can put terrific stresses on the delicate rotor assembly. Other types of vibration originate in the machinery transmitting power from the engine to the rotor, in the engine and in the blades themselves.

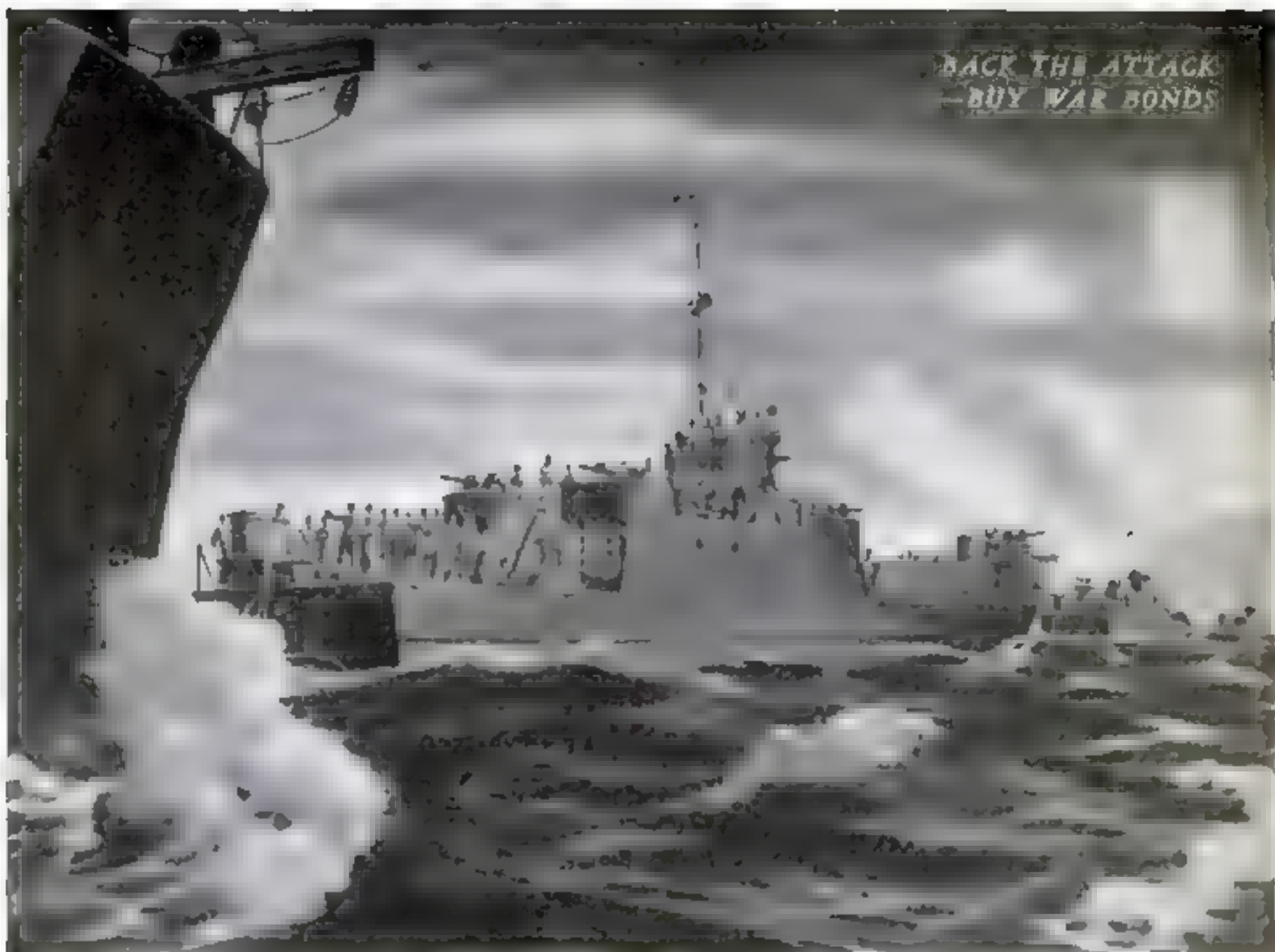
Helicopter blades will ice up deleteriously about 12 times as fast as the wing of a conventional airplane. Ice is the constant nightmare of the direct-lift engineer. Even a thin coating of ice will seriously affect the lift of a blade, owing to its narrow chord. A few more ounces of ice on one blade than on another will set up dangerous vibration moments. Ice creates drag, drag slows down the normal rotation of the rotor, and a slowed-down rotor loses a lot of its lift.

One of the worst faults that some engineers ascribe to the helicopter is an inherent inability to attain high speed. All engineers do not subscribe to that theory. Breguet of France, for instance, has contended for years that helicopters can be built that would fly faster than the fixed-wing plane.

Up to now the evidence has been on the side of those who contend that the whirligig will be consigned permanently to the 150-mile-an-hour class. That, they say, is due to "compressibility burble." As a conventional wing approaches the speed of sound, it builds up a "shock wave" immediately in front of it, producing drag. The same phenomenon is encountered by the airfoils of any propeller traveling at high speed.

The overhead rotor (or propeller) of the helicopter presents a problem peculiar to this type of aircraft. Let us assume that the tip speed of the rotor blades in hovering

(Continued on page 214)



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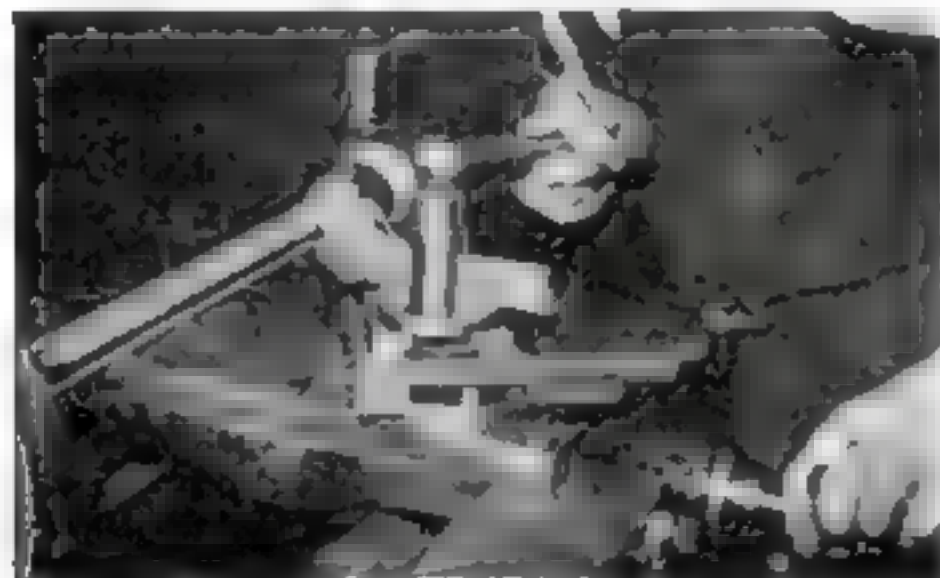
CURTISS

ELECTRIC PROPELLERS

Curtiss-Wright Corporation, Propeller Division

THE HOW AND WHY OF

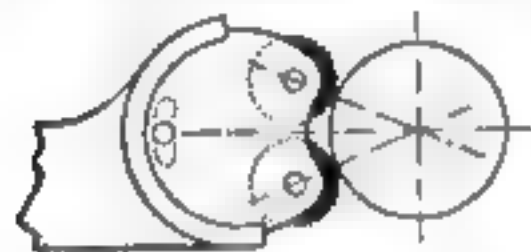
USE OF WILLIAMS' KNURLING TOOL HOLDERS



The self-centering Head of this Williams' No. 1-K Holder assures equal pressure of both Knurling Rolls against the work.

● Knurling differs from most lathe operations in that it is not a cutting, but rather an *embossing* or extruding operation. Knurling actually increases the diameter of the work. Whenever possible, work to be knurled should be held between centers. Long and extremely light pieces should be supported with a Steady Rest. In other words, the work must be prevented from springing away from the cross pressure of the knurling rolls.

Set the Knurling Tool Holder well back in the Tool Post and so positioned that top and bottom rolls are equidistant above and below center of the



work, as sketched above. Tool Post screw should be securely tightened.

With lathe in slow speed, begin at Tailstock end so as to feed towards Headstock. Force the Knurling Tool into the work—*abruptly*—to approximately full depth of the knurl. This should be accomplished *before* rolls can make one complete revolution. If the

WILLIAMS

DROP-FORGED TOOLS

knurling is to start at the extreme end of the work, start the Tool so that only half the width of the roll face contacts the work when forced in with the hand cross feed. Engage the longitudinal power feed and let the Tool travel across the face of the work for desired distance. Now reverse direction of carriage travel, without removing Tool from the impression, and feed back across the face of the work. Slight additional cross feed may be applied, as the carriage reverses, to further sharpen knurling.

Some machinists use oil when knurling—others prefer air pressure so as to blow all chips clear. Illustration below shows sample of knurling by both methods. Actually both samples are of about equal quality.

Unretouched photo of work sample. Air pressure used on knurling at the left end—oil on knurling at right. Piece is 3/4" mild steel bar; coarse knurled with Williams' No. 11-K Holder; spindle speed 250 R.P.M.; both ends knurled with one pass up and reverse.



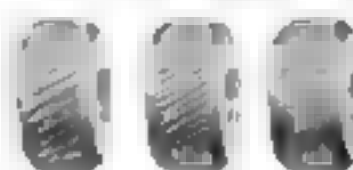
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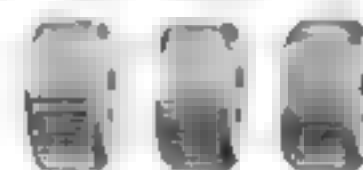


No. 11-K and 12-K, 2 sizes, 1/2" x 1-1/8" x 6-3/8" and 5/8" x 1-3/8" x 6-5/8" with Reversing Head and THREE pairs of knurls, for fine, medium and coarse work.

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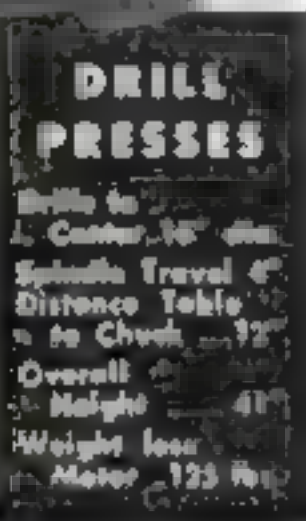
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No Helicopter Tomorrow

(Continued from page 210)

flight is 300 m.p.h. If the helicopter flies forward at 100 m.p.h., the tip speed of the blades advancing toward the line of flight becomes 300 plus 100, or 400 m.p.h. A slight increase in horizontal speed beyond that would introduce the rotor blade tips to the incidence of the shock wave and seriously impair their efficiency.

That gives the engineers a corollary worry. Using the above figures, a blade tip retreating from the line of flight would be traveling at only 200 m.p.h. Therefore the tips are subjected to the stress of changing from an impact of 400 m.p.h. to one of 200 m.p.h. about 250 times a minute, or the speed of the rotor's rotation.

Because they are highly complicated, and because they have a great many moving parts, current designs of the helicopter are inefficient. As against 20 to 30 miles that a cleanly designed small airplane will obtain in still air from a gallon of fuel, a helicopter will get only from eight to 10 miles. That will be improved, of course.

A homely disadvantage of the helicopter with the single lifting rotor is the danger that the compensating rotor on the tail will offer the private owner. Inevitably, someone will walk into it, with distressing results.

But the greatest drawback to the helicopter as a potential consumer item has been the difficulty of learning to fly it.

The helicopter's bad characteristics will be mended, but it will take time. There have been experiments in the field of jet-propelled rotors. If success were achieved with hot-air jet rotors, it would solve two problems at once—it would obviate torque reaction and it would do away with the bugaboo of icing. Only when power is applied to the rotor mechanically does torque develop. And if hot air under pressure were tubed through the blades, ice would not form.

Dr. Sikorsky, most outspoken champion of direct-lift flight, concedes that the first use for helicopters in the postwar period will be as short-haul common carriers. He sees helicopters carrying from 12 to 20 passengers on interurban runs. Perhaps they will be used, operated by expert pilots, on airport-to-city shuttle services. Because they can land straight down and take off straight up, helicopters will be invaluable in rescue work during floods.

Ultimately the private helicopter will come. Right now it is in the same stage of development as was the automobile when motorists wore goggles and linen dusters.



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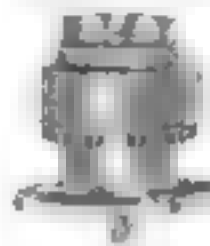
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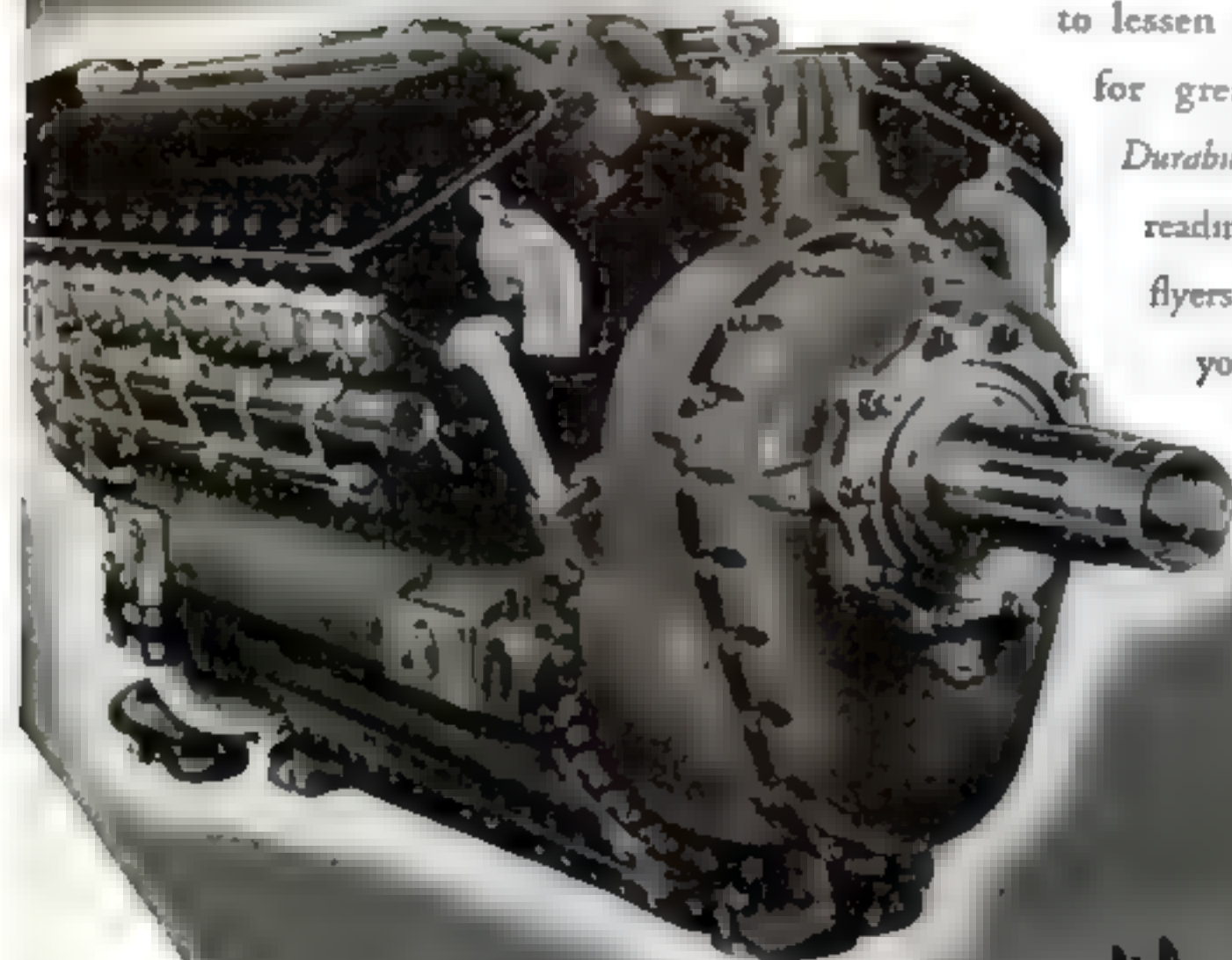
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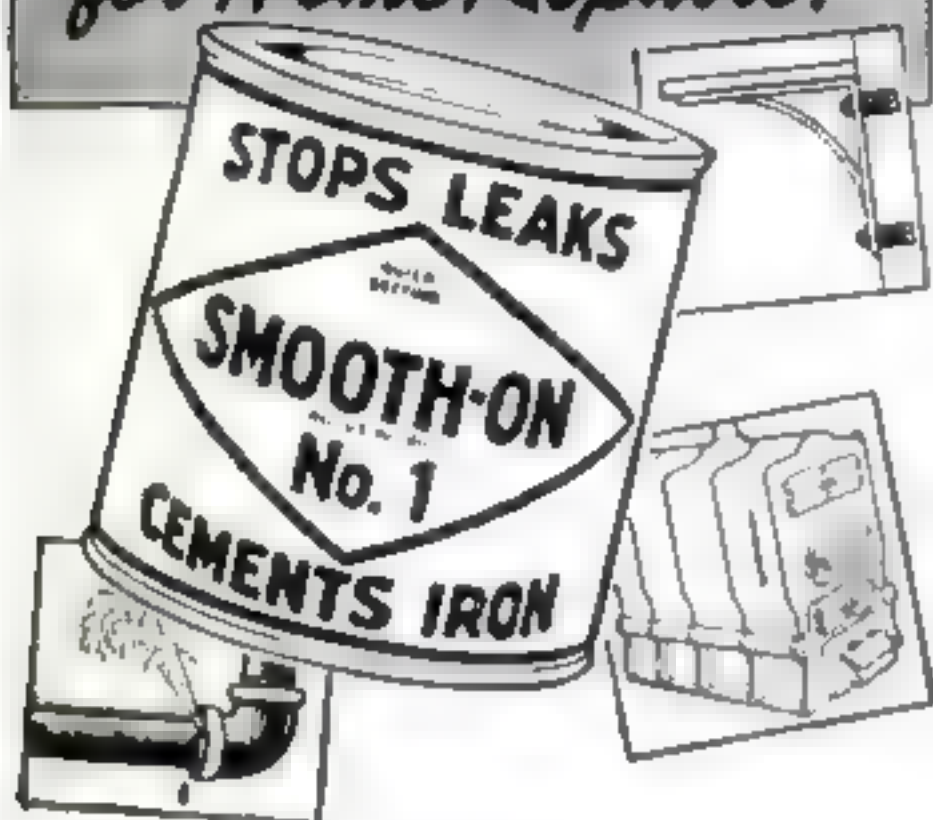


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(Continued from page 69)

line. Then the soldier stood off and threw a match at the can. There would be a small explosion, but soon it would settle down to a steady flame fed by the gasoline as it worked up through the sand. Another can with water in it would be placed on top of the first, and soon the GI would have nice, hot shaving water.

While visiting an American squadron during a lull in the Libyan campaign, I encountered a novel effort of soldiers to entertain themselves. Using an electric phonograph and some wire and other makeshift material, the men of the ground crews were able to hold a "radio" show in one tent and have it pass over a wire and be amplified in the pilots' tent 100 yards away. In the ground echelon there were a private who played a guitar, several who sang, and another who would make ringing speeches demanding that soldiers have napkins served with their C rations.

At another squadron they built an elaborate bar out of a few scraps of lumber and aluminum sheets cut from wrecked enemy planes. This was decorated with the squadron's insignia and a swastika for each German plane that the squadron had shot down. About the only thing they ever served at the bar was beer, and seldom much of that, but behind the bar they always hung a price list of fancy drinks they would never enjoy until they got back home.

Sometimes the inventive genius of American soldiers takes a much more practical turn. At one bomber base the bomb-bay doors were not opening properly on some of the ships. A sergeant replaced them with doors of his own design constructed from scraps. They worked, and later the manufacturers of the plane paid tribute to the sergeant's work.

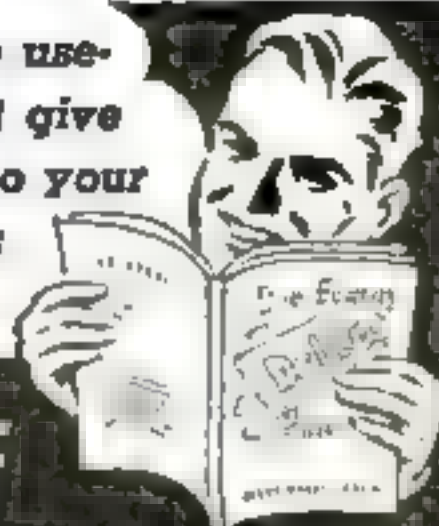
No matter where you go around the American Army, you will always see evidences of the Yank's mechanical bent. The American soldier is always thinking up something—whether it be a method of making drinking glasses out of old bottles or some scheme for making a foxhole more comfortable. Give him nothing more than a few tools and some scraps and he will cook up something useful.

One time I was waiting to catch a plane at a large airport in North Africa. In the distance I saw something speeding across the field but couldn't make out what it was. As it drew nearer, it turned out to be two American soldiers in coveralls riding on a

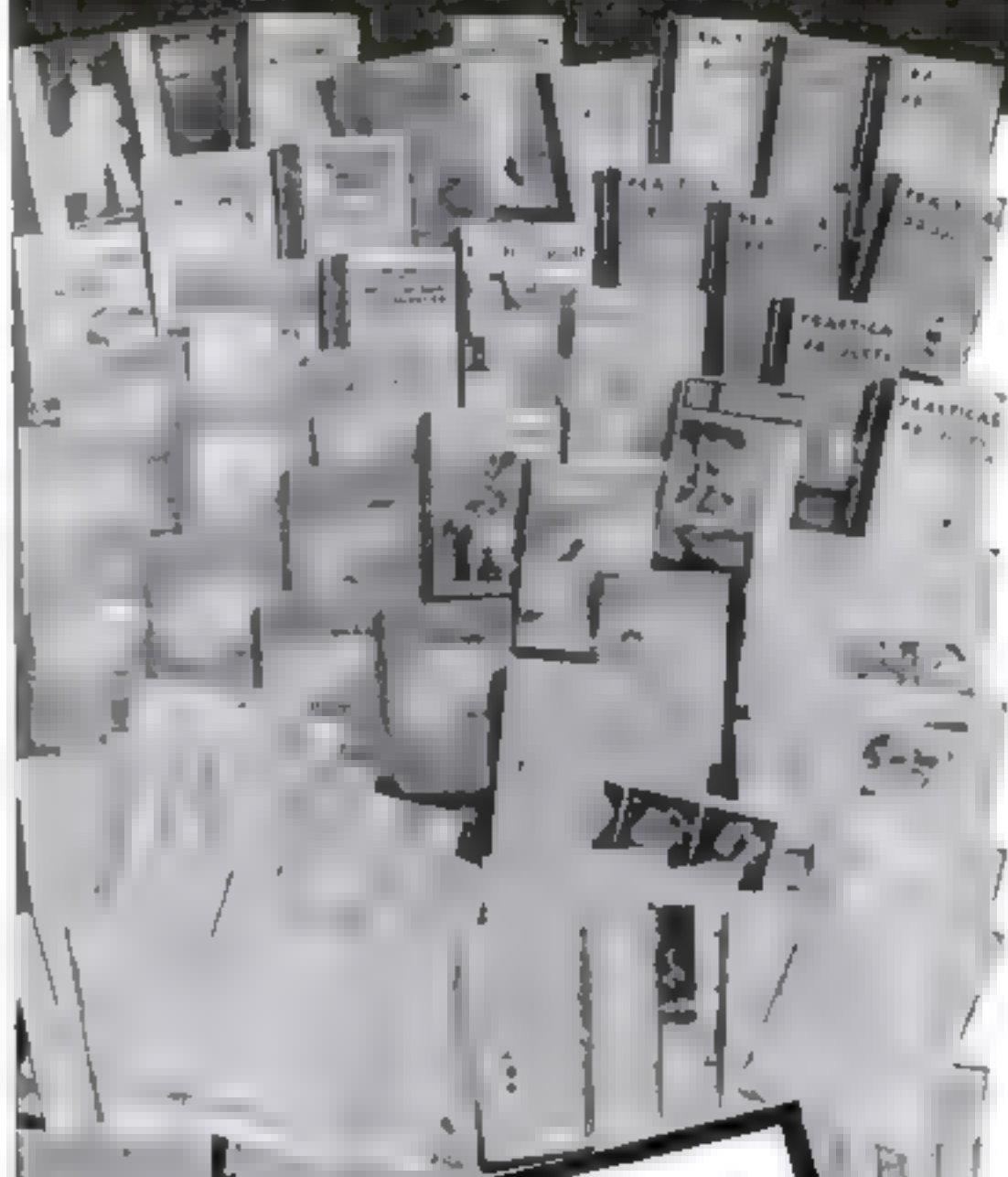
(Continued on page 222)

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Write for Free Descriptive Booklet,
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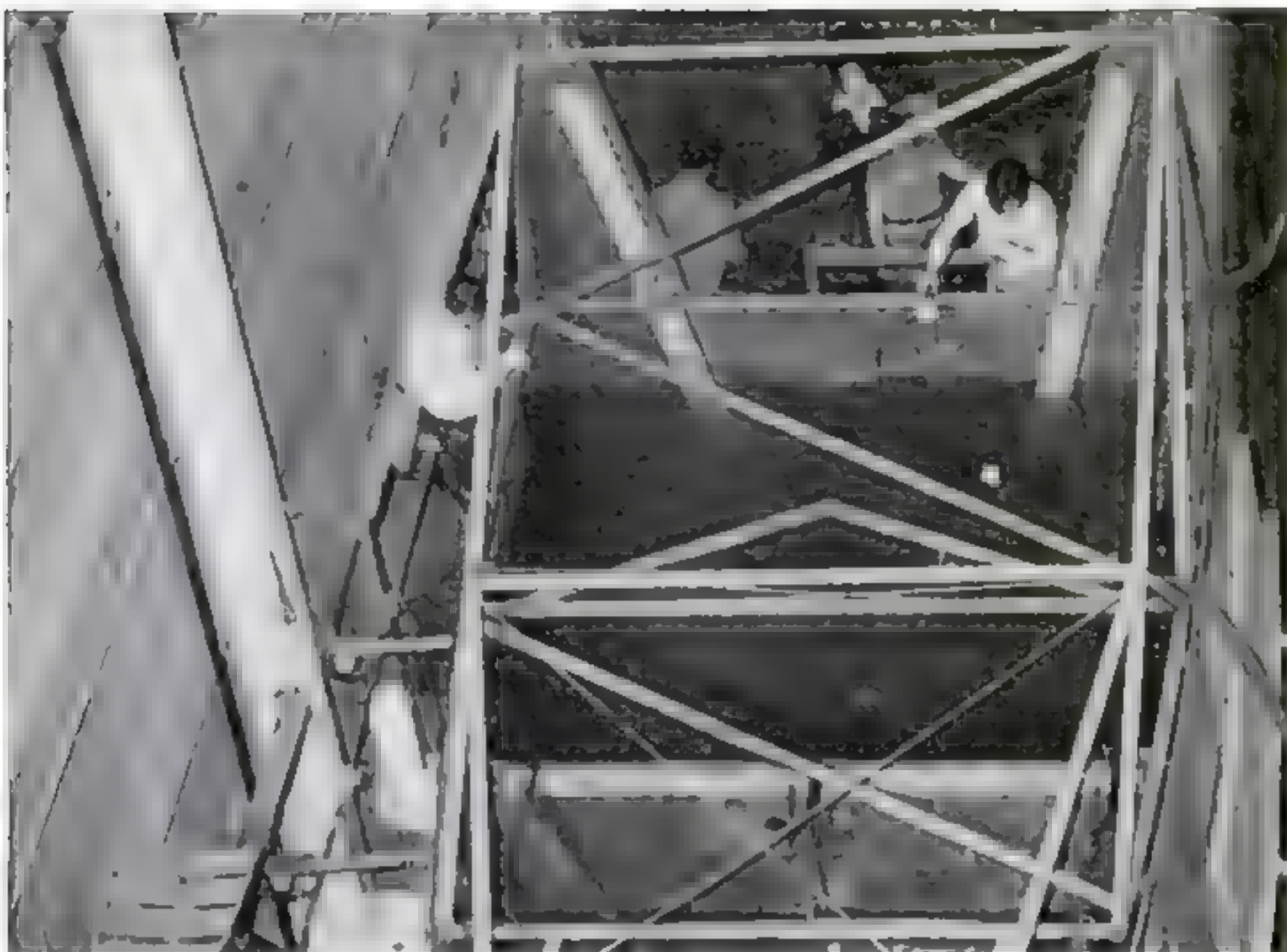
**THE NEW ZENITH
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\$40 Ready
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Complete with Radionic Tubes, Crystal Microphone, Magnetic Earphone, Batteries and Battery-Saver Circuit. One model—no "decoys". One price—\$40... One quality—Zenith's best. Covered by a liberal guarantee.

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POPULAR SCIENCE



If water cannot get out of the Consolidated Vultee Coronado, it obviously cannot get in. So to test watertightness, thousands of gallons are pumped into the six compartments of the massive patrol bomber.

A lot of "Science" is just plain Horse Sense!

Study that picture.

It shows one of the "horse sense" tests devised by the Engineering Test Laboratories, here at Consolidated Vultee. And illustrates that pure science never altogether replaces common sense.

But common sense alone could never replace the research, the intricate testing machinery, the delicate gages which Convair engineers have pioneered to make the planes we build the safest in combat—for their crews . . . the most dangerous for the enemy!

A specific example is the Celstrain gage,

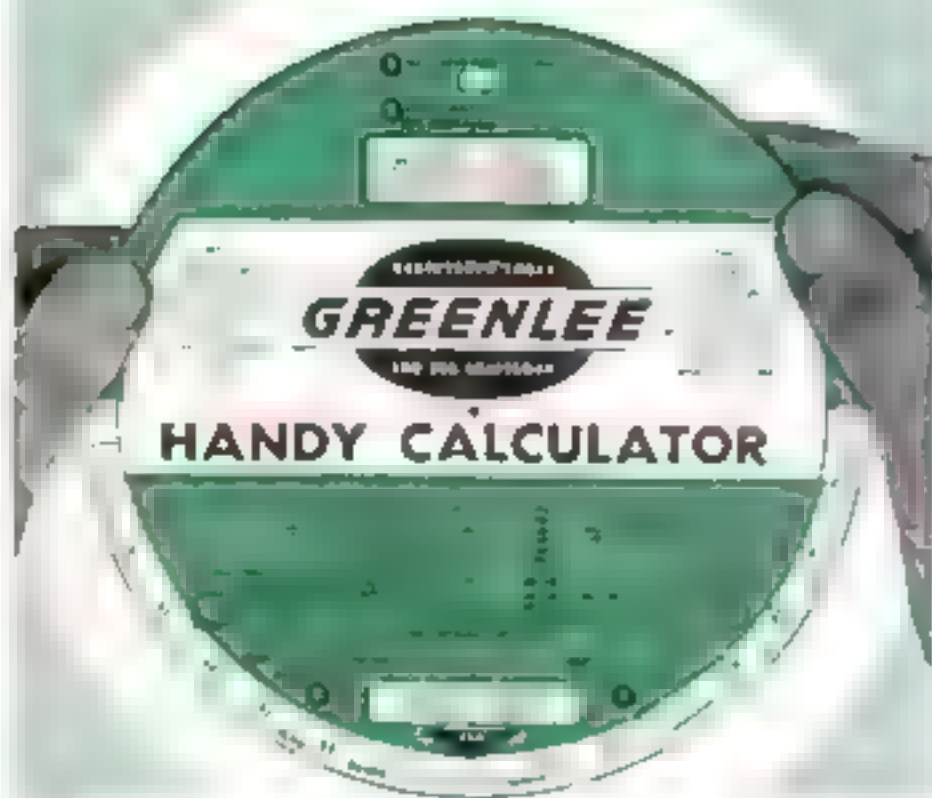
developed by Convair to show *exactly* how much strain a structure will stand. Weighing 1/150th of an ounce, these half-hair-thick gages permit stress-checking in flight, too. They take much of the danger out of test-flying, which in turn takes much of the danger out of operational flying.

The water test and the Celstrain gage are only two of the thousands of devices and techniques to come from Convair's Laboratories, all undertaken to give our flyers every possible advantage over the enemy.

CONSOLIDATED VULTEE AIRCRAFT

LIBERATOR . . . 4-engine bomber	CATALINA . . . patrol bomber	VALIANT . . . basic trainer
CORONADO . . . patrol bomber	LIBERATOR EXPRESS . transport	VENGEANCE . . . dive bomber
SENTINEL . . . "Flying Jeep"	RELIANT . . . navigational trainer	

SOLVE WOODWORKING PROBLEMS FAST!



WITH NEW HANDY CALCULATOR

All in one fast, easy-reading tool — bit sizes for head, body and thread of standard screws; nail specifications; tool sharpening hints; comparative hardness, weights, shrinkage, warpage, ease of working of various woods; conversion table linear feet to board feet; slope per foot in degrees; and an accurate protractor. And it's yours for just 10¢ as a special wartime offer from the makers of the famous GREENLEE TOOLS. Heavy, durable, varnished cardboard construction — 6" in diameter — ready to slip into your tool kit. Send coupon now!



SEND FOR YOURS NOW!

GREENLEE TOOL COMPANY, 2126 COLUMBIA AVENUE
ROCKFORD, ILLINOIS

☐ Enclosed is 10¢. Send your "Handy Calculator" by return mail.

Name _____

Address _____

City _____ State _____

Ingenuity Is Their Name

(Continued from page 218)

thing that looked like a mechanized kiddie-car. The soldiers, in order to have something to carry them across the wide expanses of the big field, had taken airplane tail wheels and mounted them on a small wooden chassis which was only about four inches from the ground. At the rear was a small motor which turned a sawed-off airplane propeller.

This gave enough power to send the thing scooting along at a surprising rate of speed. The two soldiers sat on the board in front of the little engine, like boys on a sled. I can't give any more details of this startling machine because it disappeared in a cloud of dust before I could get more than a quick look at it.

It was obvious, though, that here were two American soldiers who had solved their transportation problem out of scraps.

Magic with Magnetism

(Continued from page 132)

by some unseen force stronger than gravity.

Meanwhile a spectacular phenomenon has been developing—a miniature merry-go-round of gas bubbles between the faces of the poles and parallel to them. Incapable of being shown adequately in a time exposure, the effect nevertheless appears plainly as a white blur, when the upper magnetic pole is given a conical shape for photographic purposes. Visual observation shows striking details. If copper particles, say, have been added to the acidulated water, they will rotate in the same plane as the hydrogen bubbles, but in the opposite direction. For both, the speed of the whirligig depends upon the strength of the magnetic field. Reverse the polarity of the magnet, and each set of particles spins in the opposite direction.

Here are no wild-eyed theories, but perfectly demonstrable facts. Any skeptical physicist has a standing invitation to see them with his own eyes at Dr. Ehrenhaft's laboratory, placed at his disposal in the New York City quarters of the famous Carl Zeiss optical firm. How to account for the phenomena remains a challenge to science, unless Dr. Ehrenhaft's conclusions are to be accepted. See how neatly they would draw an analogy between well-known electric effects and new-found magnetic effects:

Bubbles or particles that travel between pole pieces of a magnet behave just as if

(Continued on page 226)

"Make it do..."



...and do it yourself"

Says Peter Putter: "Make it do... make it last... wear it out! Uncle Sam says so; and Uncle's advice is sound as a War Bond. So if you want to be a Practical Patriot, start right at home! Enlist in Home Defense against Repair Bills. These Schalk people have made it easy. Whether it's a scuffed floor, a nicked chair, a crippled paint brush, there's a handy way to fix it yourself. Best of all, the cost is small. With the single exception of Double X [the white magic that makes varnish vanish and

makes old floors new and which costs 75¢ at paint hardware stores] you can buy any one of these Household Aids for 10¢. Yet think of the dollars you save ...and all the fun you can have putting around! Ask your paint, hardware, lumber dealer. Then, send for my 'tested recipes' showing how to do your own Wartime Jobs 'round the house. It's a beautiful, full-color folder and it's free. Address: Peter Putter, c/o Schalk Chemical Company, 352 East Second Street, Los Angeles 12, California."

DOUBLE X • SAVANNESE • SCHALK'S CRACK FILLER • WAXOFF • SCHALK'S WOOD PUTTY



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Beer

Buy War Bonds

Fast Becoming
AMERICA'S NEW
FAVORITE



Never sharp... Never bitter

... Always mellow... Good Taste

Blatz Brewing Co., Milwaukee, Wis. • In our 93rd year



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**JOHNSON
SEA HORSES**
for Dependability

*Millions
of man-hours of
experience, from
over a score of
years, go into every
Sea-Horse out-
board motor built.*



DEALERSHIPS

All Sea-Horse outboard motors manufactured today are for the armed services and essential needs. But if you are interested in handling and servicing outboard motors after the war, write us now—no matter where you are located.

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WAUKEGAN, ILLINOIS

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POPULAR SCIENCE

Douglas Craftsmanship at its Best



THE CROMWELL

THE YALE

Shoes that air-condition your feet! It's sound economy, this Spring, to invest your shoe ration coupon in *quality*. That's why so many men are buying W. L. Douglas—the shoe that's made with painstaking care and styled for long-lasting good looks. Typical of Douglas craftsmanship are the two styles illustrated—easy-fitting ventilated oxfords that keep your feet cool on the hottest summer day!

\$6.50 to \$8.50

Other Styles \$5.90

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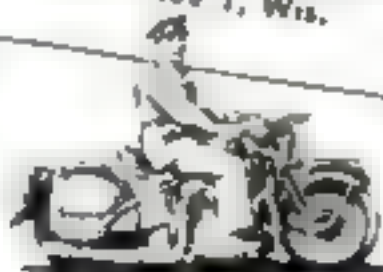


LIKE A HIGHSTRUNG
Racehorse
HARLEY-DAVIDSON
NEVER QUILTS



"AT present I'm in—, doing some throttle-twisting for the Army on a 1943, 45. You'd really get a thrill if you'd see the Harley-Davidsons plowing through mud and rain at the front. They remind you of a high-strung race horse—they never quit. I want to ride a Harley-Davidson again after the war." Thousands of riders in this country and abroad are yearning for the days to return when there'll be races, hill-climbs, endurance runs and other exciting motorcycle events. BUY WAR BONDS NOW for your Harley-Davidson motorcycle after the war.

HARLEY-DAVIDSON MOTOR COMPANY
Dept. PS, Milwaukee 1, Wis.



Write for free copy
of *THE SLANT*
MAGAZINE, filled
with motorcycle
pictures and stories.

**HARLEY-
DAVIDSON**
MOTORCYCLES

Magic with Magnetism

(Continued from page 222)

they were magnetic ions, or clusters of them—repelled by like magnetic poles, and attracted by oppositely magnetized poles. This corresponds exactly with the way that "electric" or ordinary ions interact with positive and negative electrodes. And as for the ring-around-a-rosy behavior of the hydrogen bubbles and copper particles, Dr. Ehrenhaft concludes that these are electrically charged particles—ordinary ions—rotating about a magnetic current. This would be an exact counterpart of the classical conception that magnetism rotates about a current-carrying electric conductor.

Now the staggering implications of Dr. Ehrenhaft's observations begin to unfold. Existence of such a thing as magnetic current, once established, would pave the way for industries as gigantic as those that the discovery of electricity led to in its time. A "gold rush" for practical applications might be expected. Patents for them would command fabulous sums, since inventions employing magnetic current would be basic.

What form they may take, no man can foresee, and Dr. Ehrenhaft cautiously declines to hazard a guess. Yet a visitor to his laboratory cannot resist the temptation to let his imagination run free. New kinds of motors and generators? Better ways to transmit power? Transformers that will work on direct current instead of alternating current? Atom smashers? Radical methods of seeing things in the dark, and through microscopes and telescopes? Ways to tap power from the magnetism of the earth itself? And, in your home, substitution of magnetic current—who ever got a shock from it?—for electric current? Pure dreams, all of them, today—but some of them, perhaps, realities of 2044.

Before magnetic currents could be put in harness, of course, a myriad of questions about their behavior remain to be studied and answered. So far, no one knows whether they can be led through wires, like electric currents, as well as through conducting liquids. If so, the wires might be of entirely different materials than the best conductors for electricity. Likewise, the most effective insulators for magnetic current might be substances totally unlike those used for electrical insulators. The whole subject offers as vast a field for pioneering research as electricity did a century ago. And now, as then, an amateur experimenter pattering in his basement stands as good a chance of making an epochal discovery as does a distinguished scientist in a great laboratory.

Ingenious New Technical Methods

Presented in the hope that they will
prove interesting and useful to you.



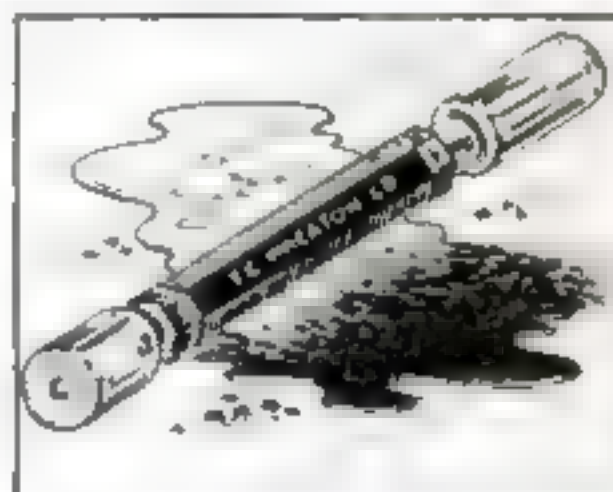
Precision Ground Glass Gages Afford Visibility in Inspection

In the hands of the skilled mechanic, glass gages bring an important plus function to precision gages. It not only checks the new tool's size, but gives the inspector an idea of what kind of surface to expect from that particular tool. The visibility permitted by the glass gage allows the inspector to see the surface in blind holes as well as through holes.

Some of the apparent advantages of the glass gage follow: Glass gages afford visibility in inspection. Glass gages are not subject to corrosion. There is less tendency to gall in some applications. Sense of feel is more pronounced when using glass gages. Because the thermal conductivity of glass is less than steel, body heat of inspectors will not be transmitted so rapidly to the gage to affect gaging dimensions.

Chewing gum, too, is really useful and helpful in these tense times to people who are working on the production front making material for our war effort. But, our Armed Forces have been constantly increasing their demands for Wrigley's Spearmint, Doublemint and Juicy Fruit. It is only natural that we and you both feel that the needs of our fighting men and women come first.

You can get complete information from Industrial Glassware Division of the T. C. Wheaton Co., Millville, N. J.



Glass gages are not subject to corrosion or rust.



Visual inspection of surface coincident with inspection for size.



.. You Can't Teach Him A Thing About Tools!

Chances are, he is way out ahead of you! One reason he's a top-of-the-shop mechanic is because good tools helped make him that way! As better, faster, more accurate and powerful tools were invented, he was quick to accept them. In his kit are mighty few tools that resemble those of his apprenticeship.

Radical advancements in hand tool efficiency have vastly increased the productiveness of America's mechanics, veterans and youngsters alike. In the tool kits of these skilled workers is convincing proof of the leadership Snap-on has given to this highly important development.

Snap-on Tools Corporation, 8000-F 20th Ave., Kenosha, Wis.



The Plane You'd Like to Own

(Continued from page 116)

vey did, however, reveal in considerable detail the points most desired in the ideal private plane. Each person interviewed was given a list of 22 items relating to such planes and asked to check them in order of preference. When the replies were tabulated, the desired features appeared in this order:

RATING	FEATURE	SELECTED BY percentage)
1	Can be soloed after four-hour instruction	45.5
2	Four-passenger cabin	43.2
3	Simplified control	38.8
4	Life expectancy of craft same as automobile	37.6
5	All metal—stainless steel	36.0
6	Good visibility, both taxiing and flying	34.2
7	Landing speed not to exceed 35 m.p.h. (Short landing run—200 feet)	33.2
8	Cruising speed of at least 120 m.p.h.	30.4
9	Folding wings or blades	24.6
10	Dual control	23.8
11	Can be operated safely from 500-ft. landing strip	17.2
12	Five-hour fuel capacity, with maximum consumption of seven gallons an hour	16.2
13	Instruments to include compass, altimeter, air-speed, oil-pressure and temperature gauges	15.8
14	Two-passenger cabin	12.2
15	Mechanical starter	11.6
16	Heater, ventilator	9.4
17	Tricycle landing gear	9.0
18	Hydraulic brakes	7.6
19	Minimum baggage capacity of 30 pounds	6.2
20	Upholstered interior, good appearance	5.2
21	Entrance on both sides	4.2
22	Push-button-control radio	2.0

Of course, many other devices and pet gadgets were added in the blank space provided. The ideal plane, it appeared, should be reasonably conventional, clean-cut, and smart in appearance, equipped with adequate instruments, roomy enough for a family and necessary luggage, comfortable in every respect—and, above all, safe.

Just what such a plane should look like and what, precisely, its equipment should be, the survey did not attempt to indicate. That's what we want to know. Send us your answer and try for a prize in the "Plane You'd Like to Own" contest.



MEET YOUR NEW NEIGHBOR . . .

Hallicrafters is the world's largest exclusive manufacturer of short wave radio communications equipment. • Today, Hallicrafters is engaged in war production only — the 1st exclusive radio manufacturer to receive the Army-Navy Production Award for the 3rd time. • Tomorrow, Hallicrafters will build YOUR radio!



SEE MORE

Far away places and strange customs seem that way only because of the limitations of travel and communications. Just as the rapid development of air travel made the world smaller, so is radio breaking down the traditional barriers of languages and ways of life. In the postwar world, short wave radio will be of utmost importance to everyone. Hallicrafters will again be the name to look to for the most advanced developments in radio.

hallicrafters RADIO

THE HALLICRAFTERS CO., MANUFACTURERS OF RADIO AND ELECTRONIC EQUIPMENT, CHICAGO 16, U. S. A.



Don't let this happen to you...

► This family has just lost one of its most essential possessions—the family automobile. It wore out and it can't be replaced. This can happen to millions of families if they continue to neglect their engines, despite repeated warnings. An automobile engine can be worn out in a few years, or made to last almost indefinitely, depending on the care it gets.

There are men in every community who know how to protect your engine and insure its long life. They are the motor service men.

Go to one of these men, and put your car in his hands, to watch and protect. It's everyone's duty to do this, as well as good judgment.

HASTINGS MANUFACTURING CO. • HASTINGS, MICH.
Hastings Mfg. of Canada, Ltd., Toronto

★ *It's a privilege to buy War Bonds*



HASTINGS STEEL-VENT

Piston Rings

TOUGH on oil-pumping • GENTLE on cylinder walls

Another Enemy Surrenders

(Continued from page 56C)

Today every soldier in mosquito country goes armed with an "aerosol bomb." Each of these specially designed containers—about twice the size of a hand grenade—contains enough pyrethrin-Freon aerosol to fumigate a pup tent 250 times or the fuselage of one of our biggest bombers 50 times.

Other insecticides besides the pyrethrins may be dissolved in Freon to produce an aerosol. The miraculous new bug-killer, DDT, was first used in powder form to protect soldiers against body lice. For months Dr. Goodhue has been experimenting with DDT. Millions of insects of many varieties—reared for the purpose—have been killed in these experiments at the Bureau's various experimental stations.

Para-dichlorobenzene, the most effective weapon known against clothes moths, dissolves readily in Freon. When aerosols become available for civilian use, they will probably be made up for use against moths as well as other household pests. A Freon-aerosol bomb in the house even makes an excellent emergency fire extinguisher!

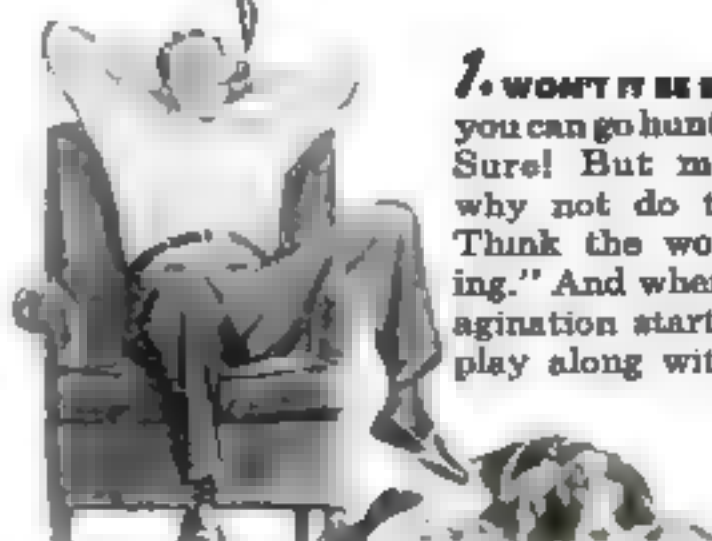
Aerosols will be a godsend to the dairy industry and countless others. Half a dozen fumigations should keep a dairy barn insect-free for an entire season. An industrial plant of 27,000,000 cubic feet capacity in Philadelphia was completely rid of insects in 20 minutes by aerosol spraying.

Mixed with nicotine instead of pyrethrin, aerosols have already been used with success as garden sprays by Department of Agriculture experts. Goodhue believes aerosols can be made in which the individual particles will be heavier, so that they will not be so likely to be blown away.

Manufacturers are working now on a container that will be cheap and satisfactory for civilian use. Because the Freon must be kept liquid under pressure, the container must be fairly heavy, and perhaps will never be turned out as cheaply as the old pump guns. A refillable container is probably the answer, and dealers will have to do the refilling, since the aerosols must be handled in pressure equipment. As for Freon itself, a pint of the liquid gas costs more than a pint of old-fashioned oil spray, but its greater efficiency—plus the power of new insecticides such as DDT—makes it cheaper in actual use.

Before the fullest usefulness of these new discoveries can be realized, much research remains to be done. Dr. P. N. Annand, head of the Bureau, feels that these accomplishments are only a beginning.

"Won't it be swell when..."



1. WON'T IT BE SWELL when you can go hunting again? Sure! But meanwhile, why not do this? . . . Think the word "hunting." And when your imagination starts to play, play along with it! . . .

2. PRESTO! No more war shortages, and you're in a store chock-full of fine guns. Look at that Remington Sportsman. Snap it to your shoulder. Fits like part of you, doesn't it? Want it? It's yours!



3. NOW FOR SOME DUCKS—on a marsh that's alive with them. Your pockets are full of Remington Express shells—powerful, long-range loads. And you're making the toughest shots look easy. Good sport, isn't it? Even only imagining. Maybe before long you'll be doing the real thing!

4. SO—right now—tie a string around your finger—write on your calendar pad—paste in your hat: *Remington means America's finest sporting arms and ammunition!*

REMINGTON is producing vast quantities of military supplies. And soon—we hope—we will once more be able to furnish sportsmen with Remington shotguns and rifles, Remington Express and Shur Shot shells, Remington Hi-Speed .22's with Kleanbore priming, and Remington big game cartridges with Core-Lokt bullets. Remington Arms Company, Inc., Bridgeport, Conn.

*If it's Remington
It's Right*



Remington

DU PONT

Sportsman, Express, Shur Shot, Hi-Speed and Kleanbore are Reg. U. S. Pat. Off. Core-Lokt is a trade mark of Remington Arms Co., Inc.

Home repairs can be handled at the drop of a hat with Weldwood Glue.

Mixed just by adding tap water to the powder, it can be used at once, sets fast (jobs can be light-worked in a few hours) and it makes a *permanent* bond.

Used and accepted by the Army, Navy, Civil Aeronautics Authority and Maritime Commission (in the manufacture of war products from PT boats to airplanes) this plastic resin adhesive actually welds woods together.

Your hardware store or lumber dealer has handy packages of Weldwood Glue in 10c, 25c, 50c and 85c (1 lb.) sizes. Get a can today or send 25c and your dealer's name for a trial 3½ oz. sample.

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"Makes the glue line the **SAFETY** line"



Weldwood Glue Has Everything!

1. Tremendous strength. 2. Waterproof, bacteria- and rot-proof. 3. Quick and easy to use. No heating. No waiting. 4. Economical. 5. Applied cold, quick setting. 6. Stain-free. Supply limited due to Uncle Sam's war needs.



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PLASTIC RESIN
WATERPROOF GLUE



It's the patented filter with its 66 mesh-screen baffles, that whirlcools the smoke—retains flakes and slugs—absorbs moisture—minimizes raw mouth and tongue bite. When filter is discolored, it has done its job. Discard it and put in a fresh one—costs only **ONE CENT**. Enjoy the benefits of Frank Medico Pipe, Cigarette and Cigar Holders.



\$1 WITH BOX
OF FILTERS **FREE!**

**REMOVABLE FILTER
IS THE HEART OF
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**GENUINE FILTERS
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PACKED ONLY IN THIS
RED & BLACK BOX**





INDIAN
TRAIL BLAZERS



Hidden Lakes

SOMEWHERE . . . cradled 'way up in the mountains where few people ever get to go . . . there's a clear, blue lake inviting you. The road up to it is too tough for a car, but to a motorcyclist, it's a snap. That's the beauty of owning an Indian . . . it'll take you to places you can't otherwise reach . . . takes you to good times and great sport . . . brings you the friendship of red-blooded

fellows everywhere. And best of all . . . an Indian handles so easily . . . responds so readily, and rides so smoothly even over rough roads that you'll feel confident and safe. Be among the first to own and ride a new Indian when this war is over.



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TO BUY AN INDIAN LATER**

Indian Motorcycle Company
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You don't have to be an expert to mend cracked walls with Rutland Patching Plaster. Just mix Rutland with water . . . wet the old plaster . . . and apply with knife or trowel. Rutland is the *original* ready-to-use patching plaster. Sets without shrinking or cracking. Extra fine and white. Makes a patch as smooth and lasting as the wall itself.



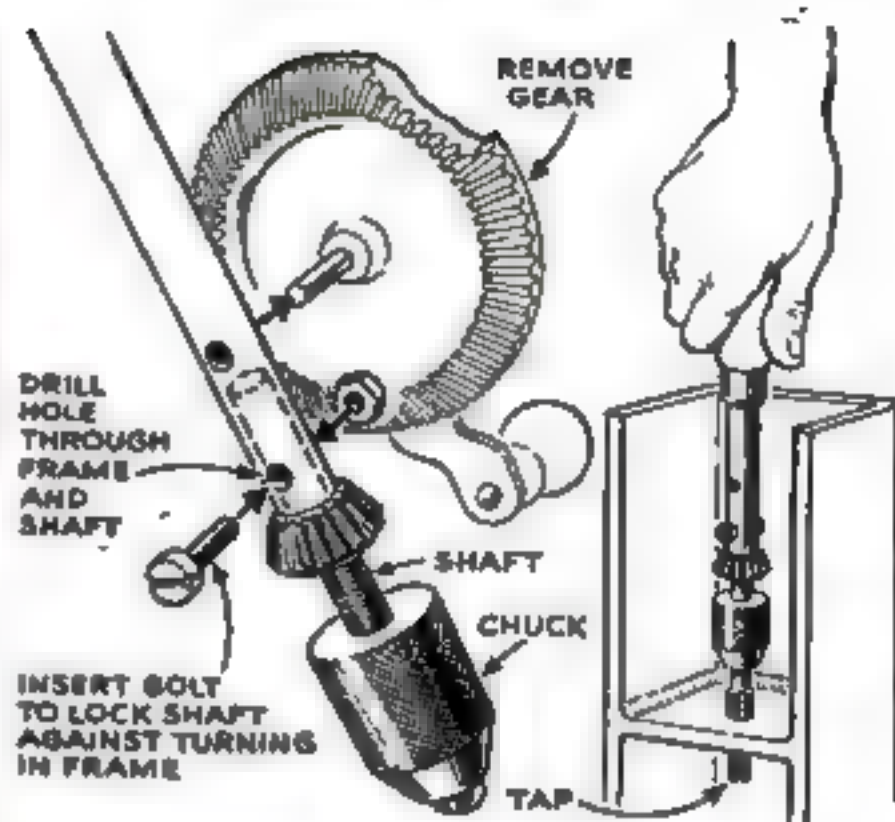
BROKEN CONCRETE

Don't let small breaks in cement floors, walks, walls, etc., get larger. Mend them promptly with Rutland Concrete Patcher. Just mix with water and apply with trowel.

RUTLAND

REPAIR PRODUCTS

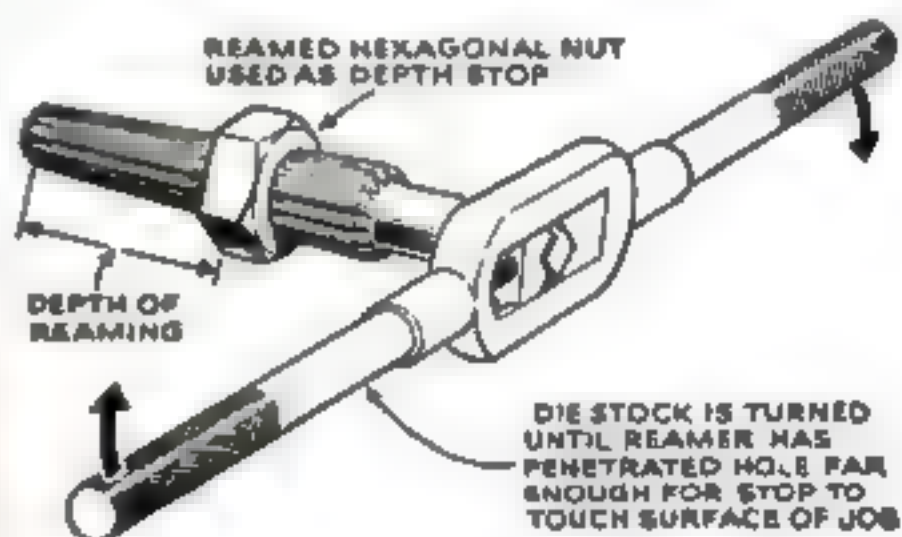
Rutland Fire Clay Company, Rutland, Vt.



Old Hand Drill Is Converted to a Special Tap Wrench

A LONG-HANDLED tap wrench adapted to threading holes in hard-to-reach places may be made from a small hand drill that is rendered useless by a worn or broken gear.

To convert the drill, remove the crank and gear; then lock the chuck by drilling through the frame and shaft and inserting a small bolt. This prevents the shaft from turning independently, allowing the chuck to be rotated by the handle.—J. M.



Stop Nut on Reamer Halts Cut at Any Predetermined Depth

IN reaming a large number of holes to an exact depth, as must for example be done if the holes are to take flush taper pins, it is a convenience to have a depth stop on the reamer. One simple way to provide such a stop is to clamp a hexagonal nut in a vise and ream it out until the reamer is as far through the nut as it is to extend into the work. The nut is left on the reamer so that it will bear against the surface of the work when the reamer has reached the desired depth.—H. D. C.





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That top one's a nice shot, soldier! It's good to know that you can find time, between cracks at the enemy, for those once-in-a-lifetime subjects. But what is better is knowing that a day is coming when *all* your shooting will be done with a camera. And when that day comes, you'll be taking *better* pictures than you've ever dreamed

of. For while we're devoting 24 precious hours a day to the production of fine military optical instruments, we're using new skills, pioneering revolutionary new methods of attaining the highest precision in large-scale production. You can be sure that these achievements will bear fruit in a series of truly great cameras after the war. Expect your next camera to be a Universal!

UNIVERSAL CAMERA CORPORATION

NEW YORK • CHICAGO • HOLLYWOOD

Peacetime Manufacturers of Mercury, Cinémaster,
Corsair Cameras and Photographic Equipment



There's only one flag
we're prouder of!



You have enjoyed such good service and long life from your AC Fuel Pump because of the quality that is built in, from design to finished pump.

You will continue that performance and quality if you insist on an AC when you need a new, or a rebuilt, fuel pump.

BUY WAR BONDS • BRING VICTORY QUICKER



While they last, these well-engineered factory-built motors offer you an opportunity for fishing and healthful relaxation without using needed gasoline. Complete with adjustable transom bracket, tiller grip switch and efficient metal propeller. Power enough for boats up to 16 feet... Ideal for trolling... silent, sturdy, simple. Operates on one or two 6 volt storage batteries. Price \$49.95, less battery.

UNIVERSAL BOAT AND LUGGAGE TRAILERS
Will handle any flat, vee or round bottom boat up to 16 feet. 8-C Trailers are well-engineered... sturdily-built with an all-metal chassis. Complete with ball-hitch and ball, and tail light. Drop-center wheels take standard size tires. Shipped in sturdy case, 78" x 42 1/2" x 12", which when fastened to chassis forms utility body or luggage carrier for 1000-lb. load. Assembled easily and quickly by anyone. Price \$89.50 less tires.

Above prices are F.O.B. Silver Creek, N.Y., or thru your local marine or sporting goods dealer. Ask him, or write for descriptive folder. Retail orders sent to the factory will be shipped C.O.D. Supply is limited.



SILVER CREEK PRECISION CORP.
3 Mechanics St., Silver Creek, N.Y.

A FAST WORKER on Hard-to-Get-At Spots

for Radio Panels
Switchboards, General Use

XCELITE Hollow Shaft Nut Drivers



Awkwardly located nuts on radio panels, telephone and power switchboards—especially nuts with protruding bolts or studs—are readily handled with this unique, time-saving tool. Handle of genuine, transparent Xcelite plastic, shock-proof and fire-resistant. Hollow shafts are made of high quality steel, with deep precision-formed sockets. Available in seven nut sizes, from 5/16" to 3/4". Also supplied with insulated shafts if desired. Most Xcelite Tools are available on satisfactory priorities—delivery is necessarily delayed by war conditions. Ask your hardware, radio or electric dealer—or write Dept. L.

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Back the Attack—Buy More War Bonds

XCELITE

QUALITY TOOLS
PREFERRED BY THE EXPERTS

OVERSEAS SERVICE

After victory the HULL COM-PASS will return from overseas service, too—ready for civilian driving—an improved and battle-tested guide for your car.

HULL MFG. CO.
P.O. Box 246-EG,
WARREN, OHIO



UP 1 1/2" LATHE CAPACITY TO 3/4" ...
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Red Nail Polish Marks Slide to Prevent Waste of Film

EVEN professional photographers sometimes waste film through such commonplace mishaps as reusing an exposed cut-film holder, or shooting a picture with the safety slide in place. While the best insurance against these mischances is to develop good photographic habits by following a fixed routine, there are several kinks involving the use of red nail polish that make it easier to avoid these careless accidents.

One trick is to paint a small circle of polish on the side of the slide which normally faces the film. After making the shot it is then necessary only to replace the slide with the circle on the outside, and you will be able to tell at a glance if the holder has been used. This need not supplant the conventional method of making an exposure notation on the holder, but it will help on occasions when time to get the picture is fleeting.

Another idea is to paint the outer end of each slide a bright red. With so conspicuous a slide, the risk of snapping a shot without first removing the slide is considerably reduced.—G. H. SCHOENBERG.

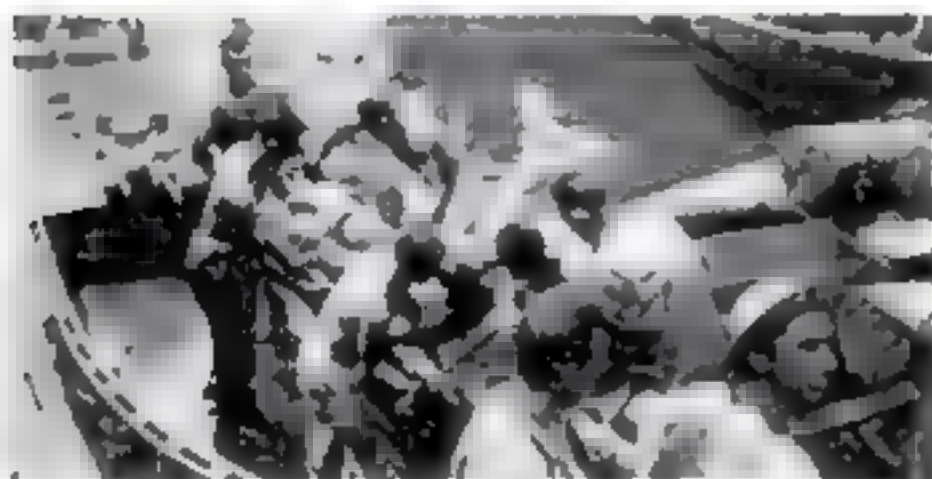
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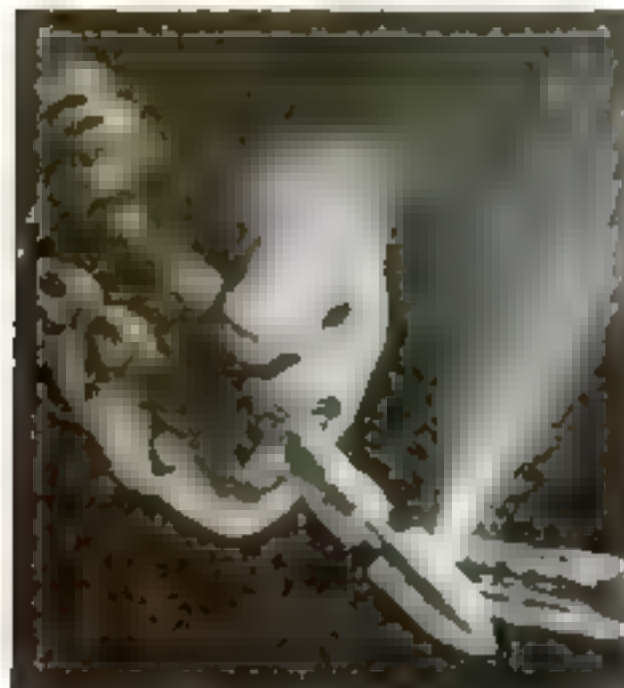
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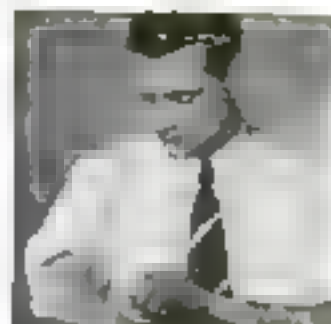
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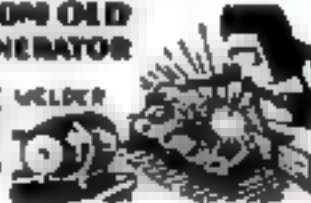
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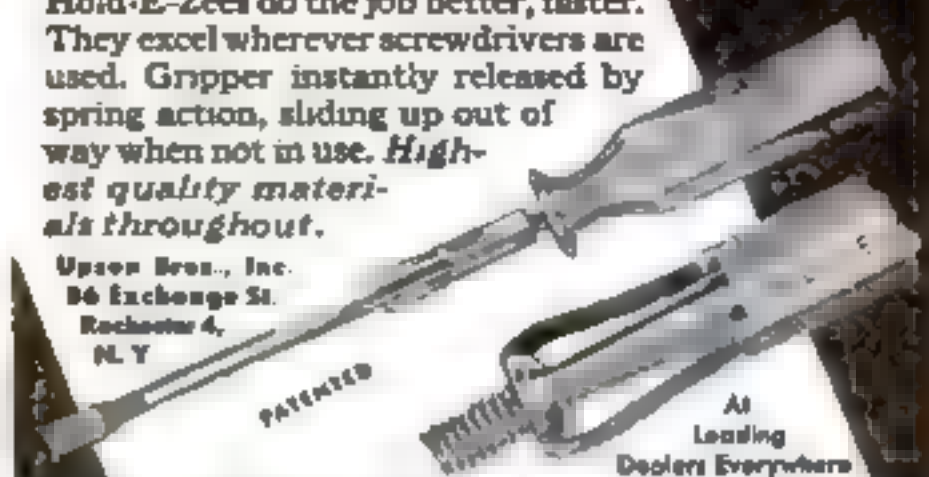
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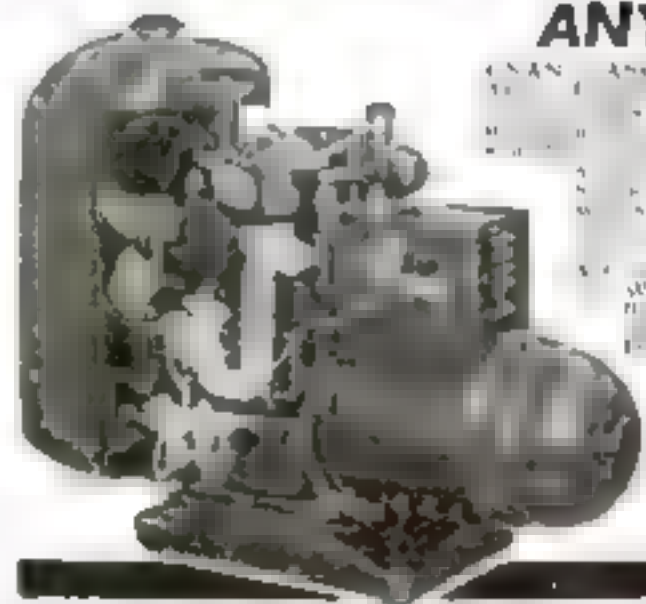
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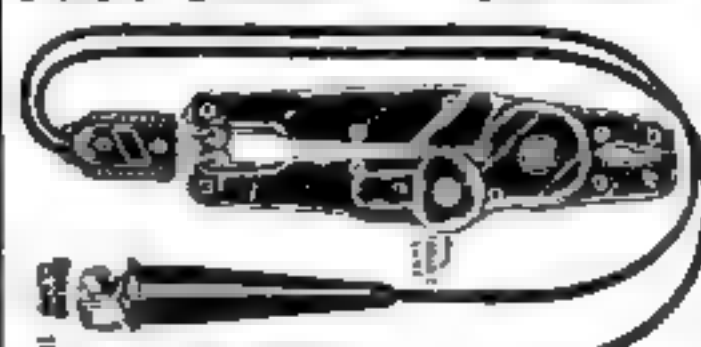
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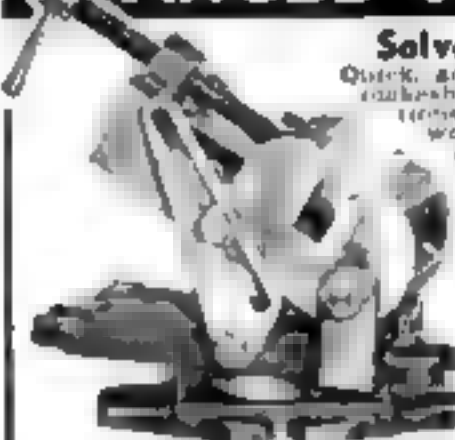
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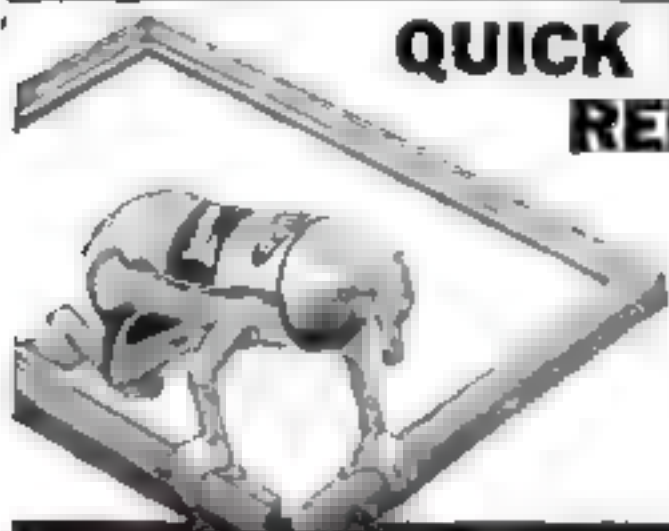
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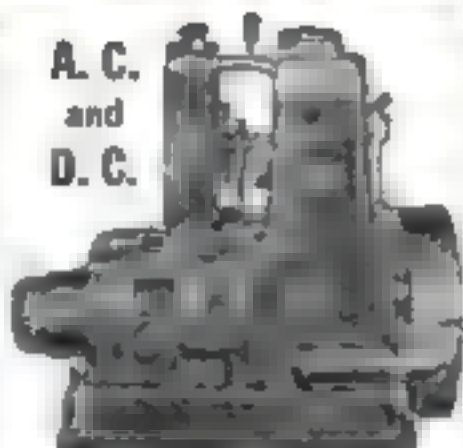
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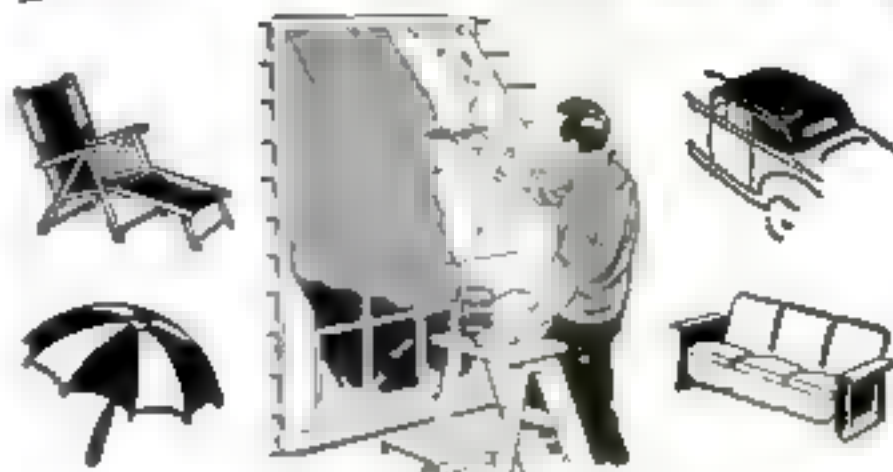
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webbing foundation, it is advisable to replace it with new material, but old webbing may be restretched firmly if it is still strong. Most chairs of this kind, however, have some type of spring seat. The springs should be tied in place and covered with burlap or heavy unbleached muslin.

Over this covering place one layer of cotton felt, stretch denim over the felt, and tack the denim around the edges. A roll filled with stuffing is next tacked across at the top of the front edge of the seat. If a round wooden stick, about 1" in diameter, is padded with a layer of cotton and then covered, it can be used for this purpose. To get a perfect fitting for the cushion, it is advisable to cut the cushion covering to shape after the back and arms have been upholstered. This cushion will add materially to the beauty of the chair if it is made of box-type construction, that is, with a fitted top and bottom stitched to sidepieces and edged with piping. The cushion can be filled with kapok, felt, cotton, or feathers.

Stretch burlap over the back and the insides of the arms. In order to have the padded folds equally divided, locate the center of the back and mark off the first fold so that it is split by this center line. Then divide the remainder of each side into the desired number of folds. In the case of this typical chair, the number of stuffed folds each side of the center fold is six, thus making 13 folds or tubes in all.

Cut as many pieces of covering as there are folds to be stuffed, shaping each piece as indicated by the white lines marked on the burlap, but allowing 3" extra in width on each piece to take the stuffing. Also allow extra length for tacking to the seat at the bottom and for reaching over the top and tacking on the outside of the frame. The two end folds should be cut wide enough to permit tacking the cover around the arms. All the pieces are sewed together, so allow $\frac{1}{2}$ " in the width for each seam, or a total of 4" extra including the 3" allowed for stuffing.

Starting at the middle of the back, sew the two center seams of the covering to the marks on each side of the center line and tack the bottom to the seat. Fill the center fold thus formed with stuffing. Then sew on the adjacent seams, alternating until the end folds have been filled, stretched around the fronts of the arms, and tacked on the outside. Next, fold the material neatly over the top of back and arms and tack it firmly in place.

The outside of the back and arms is then covered with the upholstery fabric, the edges being neatly folded under and tacked. The box-pleated skirt is finally tacked all around. Make the size and width of the box pleats appropriate for the length of the skirt and the type of covering used. For the average chair, a box pleat 2" wide with a 1" space between the pleats is suitable.

3 These folds are cut, sewed together, and then applied and stuffed one at a time. Ends and front edges are tacked down. A strip of the material is attached to the seat front



4 Finally the outside of the back and arms is covered, a box-pleated skirt is tacked on, and a cushion is made to shape, sewed with piped edges, and filled with suitable stuffing material





Maurine, portrayed here at work, is a Hollywood still photographer

SHOOTING Still Portraits LIKE HOLLYWOOD Close-Ups

By MAURINE

1. Without make-up or hair-do, even a very handsome person can look washed out to the camera. 2. Maurine changes her subject's hair and applies thin foundation cream, lipstick, mascara, and eyebrow pencil. Here only one side of the face is made up in order to show contrast. 3. Powder will cut down high lights, subduing prominent features, but in this case the bridge of the subject's small nose is deliberately high-lighted. 4. Even without retouching, this first proof reveals improvement. A finished photo is shown on page 170

WHY are portraits of our friends and family seldom completely satisfactory? What really constitutes good and exciting photography? The answers, I believe, may be found by studying any of the top-notch current motion pictures. The photography you will see in them may be safely accepted as a criterion.

Have you ever noticed how well the close-ups of heroes and heroines bring out all their best qualities? Of course you have. And that is the way most of us would like to look in our own portraits — natural, graceful, animated by some mood or emotion. The effect is harder to achieve in a still picture, but it is well worth the effort.

While I was employed at one of the Hollywood studios as a stand-in for Jeannette MacDonald, I had an opportunity to observe the methods, and also the trials and tribulations, of some of the finest cameramen in the motion-picture business. I found myself becoming increasingly interested in the technique they employ to produce the thrilling and beautiful effects seen so often on the screen, and I



POPULAR SCIENCE

wondered why still photographers did not attempt to improve on the old standard lighting and to create these same effects in their portraiture.

It was interesting to try to figure out why the huge lights were constantly being shifted about, turned on and off, diffused or made hotter, silked or screened, or spread. I became so fascinated that what began as an avenue of escape from boredom was soon replaced by deep interest and conscious observation. I gradually absorbed much of the technique of lighting and posing; discovered how moods could be created by the play of light and shadow, how "low-key" lighting, shadowy and dramatic, could bring out a feeling of intrigue, suspense, danger, or fear, and how a "high key" called up gayer, happier moods or bright, sunny effects.

One day, hearing my rapt description of some of these things, a friend suggested that I become a photographer myself. That had never occurred to me, but from then on I was to try out the ideas and plans I had formed. I took a desperate chance and left the movie studio to open a place of my own. To my delight, I found that what I had learned could really be put to work. Not many months passed before I was actually photographing the stars I had imagined shooting in my daydreams.

Myrna Loy was my first big-name client, and her pleasure over her pictures—plus the big check which meant the acquisition of much-needed new equipment—convinced me that the idea of using motion-picture technique in still photography had really begun to work out as I had hoped.

I still try to keep up-to-date by seeing as many good movies as possible, and I see

them more than once. The first time, I enjoy the story; the second time, I study the lighting effects and try to figure out how they were achieved. I make mental notes when some especially good bit of work flashes on the screen, and later I attempt to duplicate it with a subject in my studio.

But lighting is only a part of the success of a fine portrait. Since the camera does not record on film the colorings the eye sees, compensation must be made through the use of make-up to create a natural appearance and to eliminate much of the retouching that often spoils a picture. Without make-up or retouching, even a very handsome person is apt to look pretty washed out in a photograph. Try having your favorite snapshot blown up to an 8" by 10" print; then see how defects shine out alarmingly.

The best foundation for a good make-up is a scrupulously clean skin. On this apply a very thin oil base two shades darker than the natural skin—not the heavy grease paint so commonly used by professionals on stage and screen. Perhaps a good sun tan best describes the desired shade.

Powder lightly those areas where high lights are undesirable, especially under the eyes, around the nostrils, and—to prevent the running of lipstick—around the mouth. Large or unattractive noses and other facial irregularities should be powdered also to subdue them.

To prepare the eyebrows, draw faintly the most becoming line from the center to the outer tips. If necessary, underline the brow above the original line, but take care—lines that are too heavily drawn are likely to bring out a harsh, villainous look that will defeat your purpose.





In addition to being made up, the subject is put at ease. When a mood like this one is caught, the photo takes on a Hollywood quality

For eye shadow I prefer brown; it gives a cleaner dark tone than any other shade I have tried. In applying it, extend the shadow lightly to the brow line. If the bridge of the subject's nose is narrow and the eyes are set close together, apply a lighter base on either side of the bridge. This tends to high-light the area and will help to separate the eyes.

Since full mouths are the accepted vogue, it is a good idea to widen the subject's mouth a bit. Use a medium, clear-red lipstick with enough oily consistency to spread with a make-up brush. Follow the general shape, avoiding full curves near the corners of the upper lip. On short upper lips brush on a more shallow bow at the center than on broad mouths. Let good taste govern your efforts.

These aids, judiciously applied, will result in naturalness in the finished picture. The photograph above illustrates what can be done, while a series on the preceding pages shows the steps taken in making up the subject to look her best.

For an example of how make-up will help a subject of your own, try using a lighter base for receding areas that you wish to bring out of the shadow. In this way you can create a condition for high lights to be caught up and accentuated by your illumination. Conversely, light-orange powder rouge will produce clear shadow effects on prominent areas, such as the cheek bones, where they may be especially desirable. Using these two principles, you can straighten an off-set nose, for example, by lightening the straight side and rouging the crooked side, thus gaining a high light on the one and a shaded area on the other.

Follow the same general practice when photographing men. Use a darker base, but do not apply powder except to smooth out irregularities. Lipstick? Certainly—no matter how they protest. Follow the contour of the mouth with a light-pink lipstick, blending it at the edges with the finger. Pink gives the mouth a little shade to help set it off.

These preparations are not nearly so complex as they may seem. You'll enjoy experimenting with make-up, and when your subject looks pleasing, he will be ready for your camera.

Then here is where the psychological angle enters. The process of being made up may itself take the subject's mind off the camera. He must be relaxed, at ease, and, for some studies, obviously interested in something beyond the camera. The lighting must suit both his personality and the mood you wish to capture.

In fact, you can be sure that a portrait, to be truly satisfying, has to be a real camera study in the fullest sense of the term. Thought, planning, and some shrewd character reading are all necessary. While make-up, pose, expression, background (if you feel you need it), and lighting are each important, they must harmonize in the finished photograph. Otherwise, instead of a top-notch portrait, you may wind up with a picture that shows a good make-up job or clever posing, or snappy lighting—and

nothing else. In portraits as in a lot of things, it's the effect that counts, not your personal techniques for achieving it.

Lighting rules? One simple formula is this: place the key light at that point where its beams make the facial features look their best; then place the fill light directly in front on a level with the face. Other lights help, but these are the only two I consider essential for practical results. Of course, too, the two lights can be varied somewhat for special purposes, such as to get the effect achieved in the photograph of the attractive girl on this page.

But forget such terms as butterfly shadow and Rembrandt lighting. The key doesn't necessarily belong directly above the nose. Experiment a little, moving the key around until it casts a satisfactory nose shadow. As a rule, when the nose shadow pleases you, the rest of the face will also be generally pleasing.

Nor does it matter whether you employ a spot, a flood, or sunlight as your key light. Often a single light will be adequate, especially for particular effects embodying strong high lights and deep shadows.

The fill light should cast no shadows. Its purpose is merely to fill and to soften the shadows previously created. If you desire

additional lighting, first softly illuminate the hair from one or both sides or from the back. Should still more lighting equipment be available, light the background separately. Finally, light the clothing.

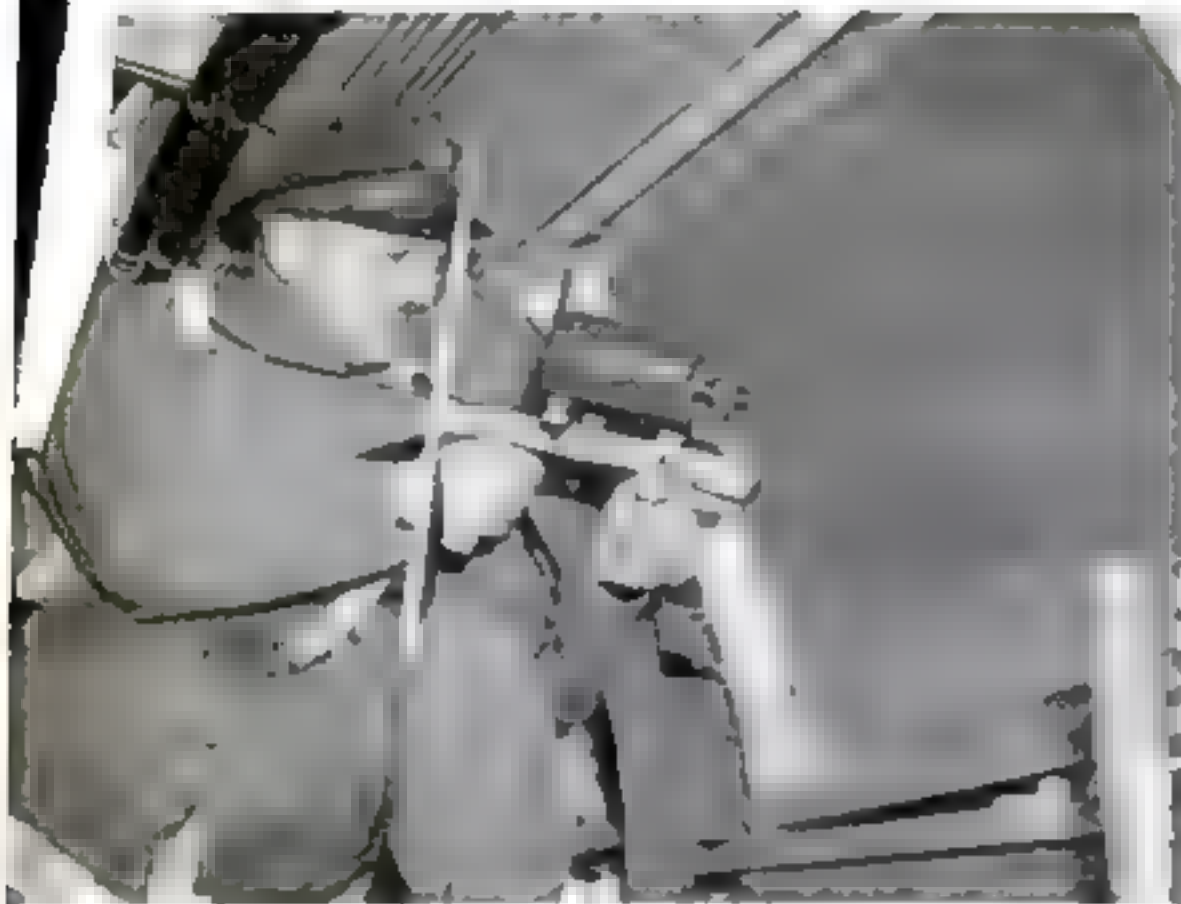
No matter whether you use one light or seven, always count on the high lights being hotter than they appear and on the shadows registering darker. Better a long exposure to capture all the light than a fast exposure to compensate for overlighting.

Don't be afraid of indulging in a little "play acting" when your subject is ready. Imagine he or she is the star of some picture you have enjoyed. As you arrange the lights, talk about anything that will take his mind off the lights, camera, and make-up. Concentrate on a topic of special interest. If convenient, engage him in conversation with a friend outside the camera field. The instant he smiles, frowns, or laughs, or expresses some fleeting mood of photographable interest, capture his expression by snapping the shutter.

Maybe the word "psychology" doesn't fit this method. Perhaps you have a better term. I'll wager, though, that close study of good motion pictures will help you to make better portraits than you ever even dreamed would be possible.

Only two 500-watt lights were used in this charming photo. The key light was placed low and at the left





RUNNING AIR BATTLES have been made easier to photograph by a motion-picture camera gun improvised by Capt. Ray A. Flinsky, of the Eighth Army Air Force, who is shown at left demonstrating his device somewhere in England. Fabricated in part of fittings from a retired Flying Fortress, the gun is wired so that it can be plugged into the electrical system of a plane to obtain power for the camera heating units, vital at high altitudes. The short wooden stock of the gun enables an operator to point the camera like a rifle, aim being taken through an open, rectangular gun sight similar to those used on 50-cal. machine guns, and the film runs as the trigger is pulled.

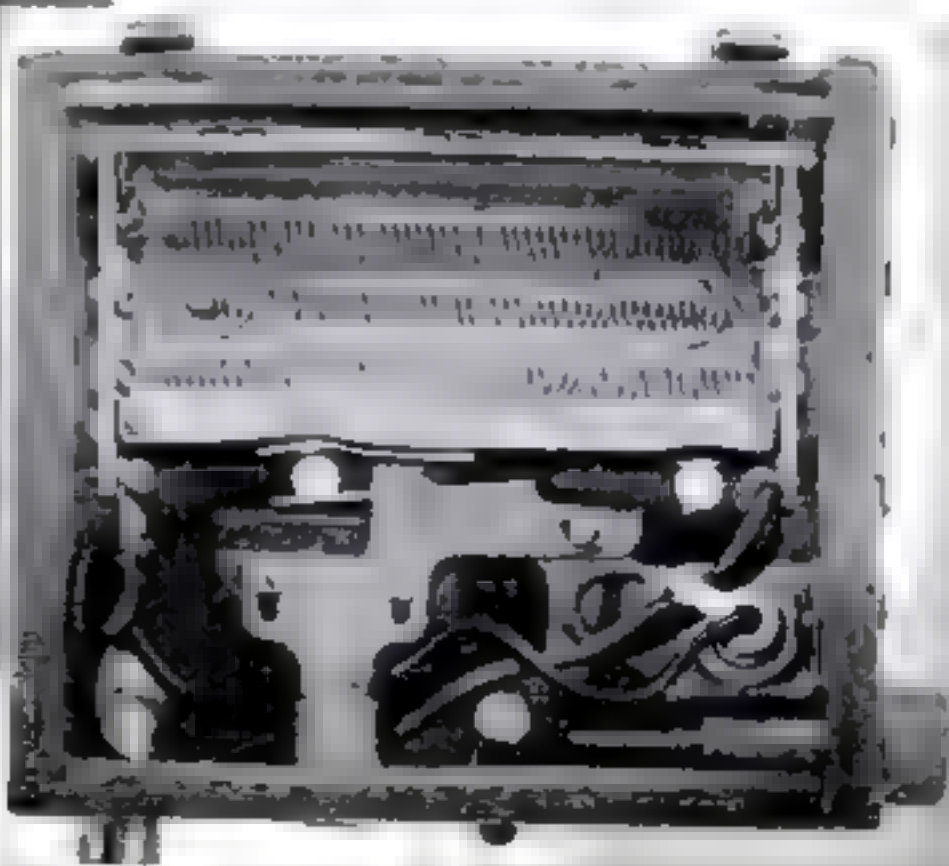
KEEPING A MOVIE CAMERA WARM in sub-zero weather has been solved with a practical heater jacket that fits over the camera slide cover. The device consists of a three-coil heater element mounted on a copper-plate deflector. Current flowing to it from a battery is controlled by a microswitch

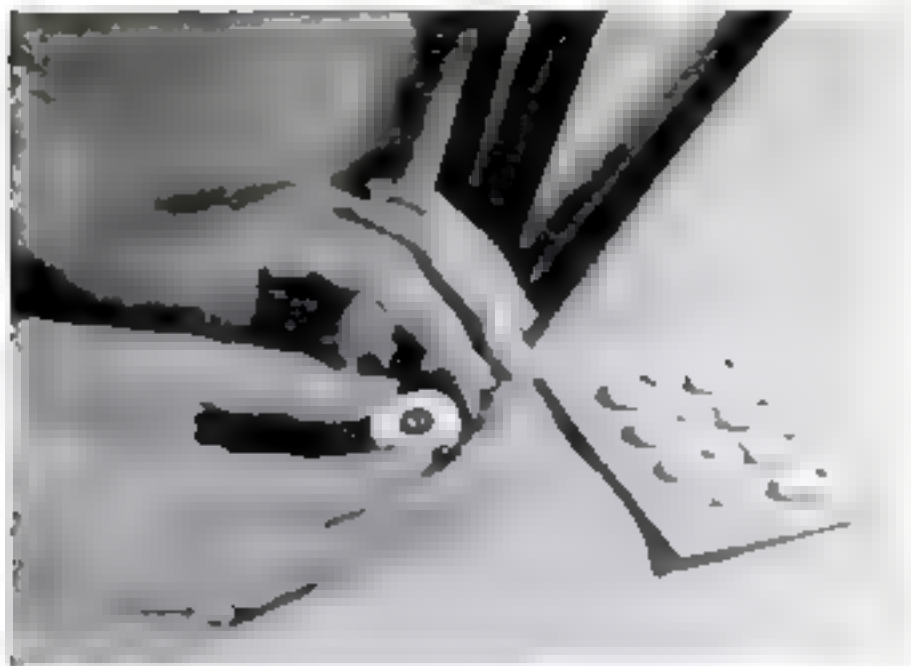
actuated by a bimetallic thermostat. Tension is adjusted by means of a dial.

Need for such a device was experienced by Charles L. Center, shown using the apparatus at left and a member of the Studebaker Corporation research staff, while testing and photographing military equipment in the Canadian Rockies. Noting that metal parts of his camera contracted and bound in the cold, resulting in jerky, fast movies, he solved the problem temporarily by shooting through an aperture in a heated tent.

Later, with the help of R. P. Roberts, Studebaker electrician, and H. R. Greenlee, special company engineer, he developed the portable heat jacket, which has functioned efficiently at 45 below.

Battery-heated elements and a copper deflector (below) prevent jerky action by warming the mechanism of a movie camera in sub-zero weather, as at left

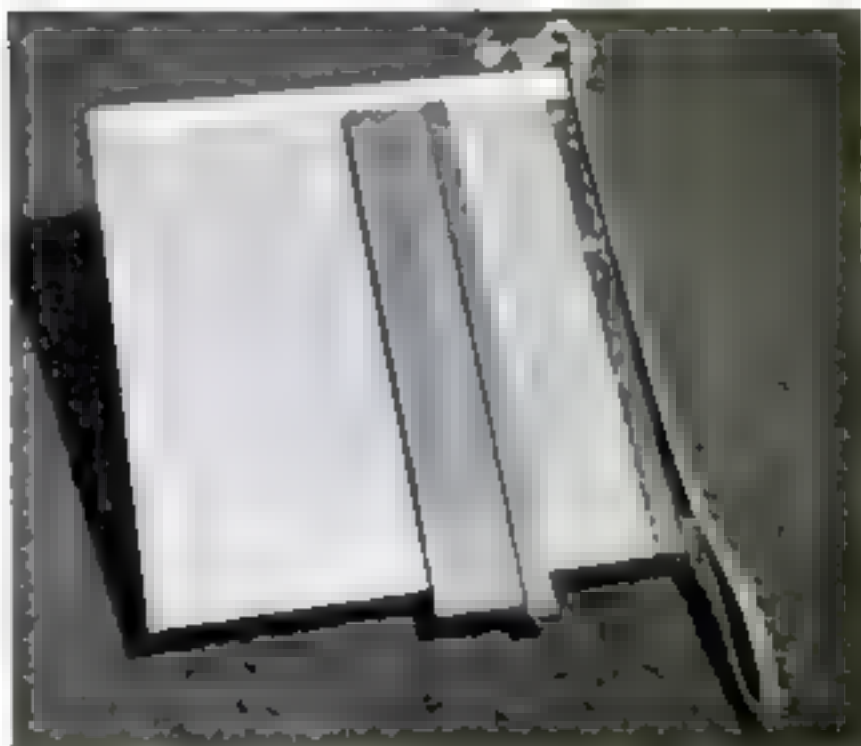




A GOOD PROTECTION against scratching or tearing the leather covering of a camera on the tilt-top head of a tripod is an ordinary ring-shaped corn plaster slipped over the screw. If desired, the plaster can be secured to the top by moistening its gummed surface. In cases where the tripod socket of the camera is too shallow to accommodate the entire length of the screw, a corn plaster of the same kind will also serve as a resilient washer and permit the firm seating of the camera.—WILLIAM SWALLOW.

ENLARGEMENT EXPOSURE TIME can be determined by means of the red filter when a negative of average density is put in an enlarger and projected on an easel in the usual manner. Place the filter over the lens and stop down the diaphragm until the darkest shadow of the picture, revealed as

TRIMMING-BOARD GAUGE. Cutting photographic paper in a darkroom is facilitated by fitting a 1" wide strip of wood with two dowels on the center line and mounting it in holes bored at the ends of, say, the 5" line of a cutting board, thus gauging a 4½" cut. For use in making narrower cuts, two other strips, ½" and 1" wide, may be laid beside the first. Both are in use below for gauging a 3" cut.—F. BRAUCKMANN.

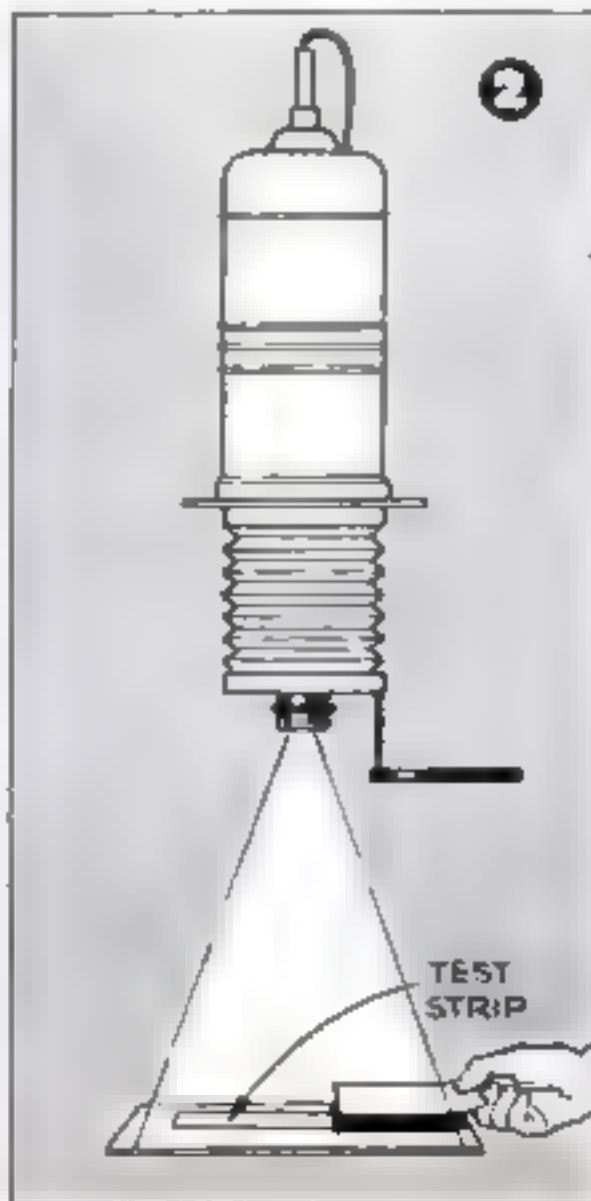
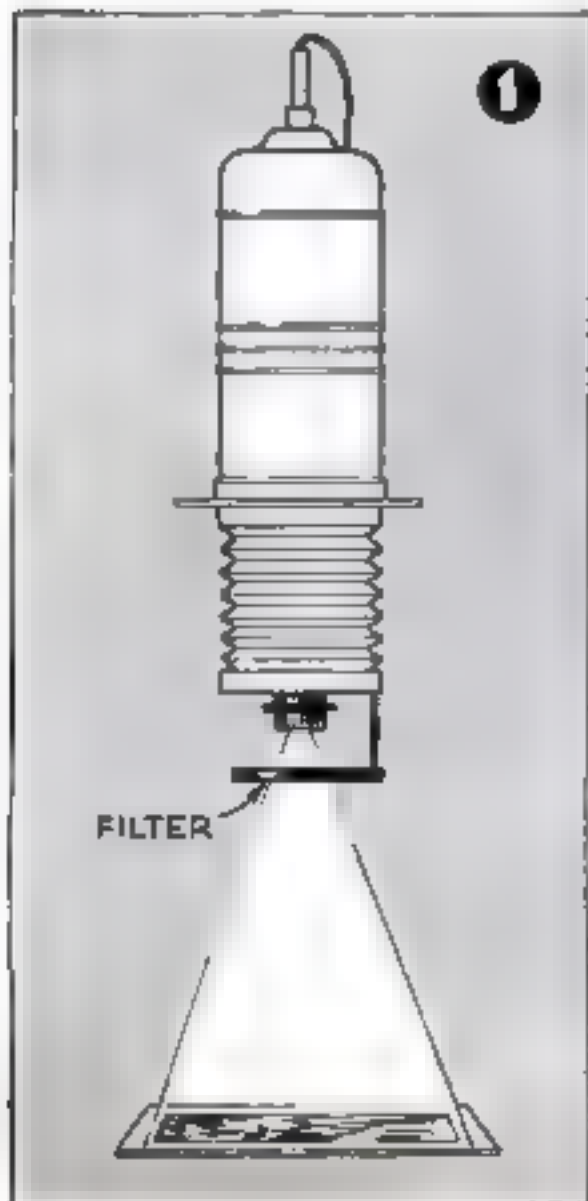


the brightest spot on the easel, is just visible. Then remove the filter and use test strips to determine the proper exposure time for a full-scale print.

All subsequent negatives, whether above or below average density, can then be printed with the same exposure time. All

that is necessary is to adjust the diaphragm, with the filter on, until the brightest area is just seen.

When one area of a print requires dodging or local printing, the diaphragm should be closed down until the brightest spot in the area is barely discernible. The *f* number should then be read and compared with the value of the over-all print. For example, if the *f* number of the locality is 11 and the full-scale number is 8, a comparison will indicate that the treated area needs one quarter the exposure of the whole print. Over-all exposure times will be constant for any one grade of paper, and should be filed away for ready reference.—ROBERT F. BENENATI.

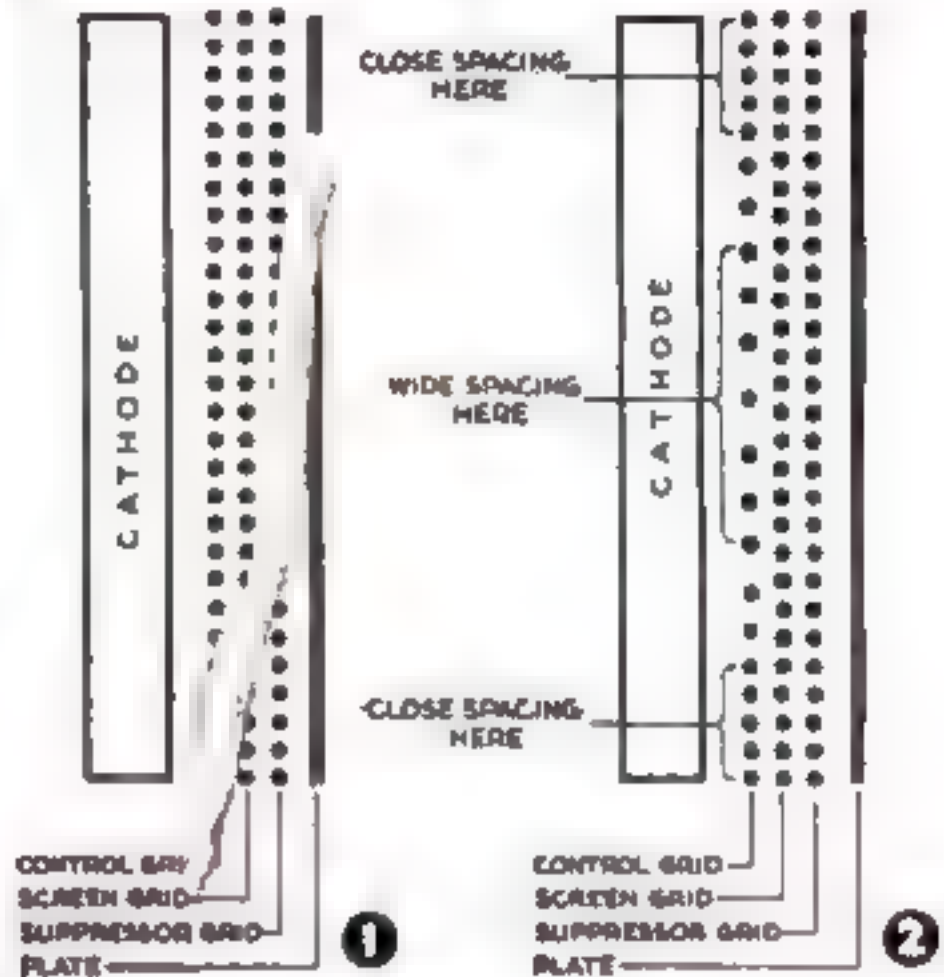




WHAT TUBE

6SJ7-CONTROL-GRID
WIRES EVENLY SPACED

6SK7-CONTROL-GRID
WIRES NOT EVENLY SPACED



Knowing Six Basic Types Will Enable You to Adapt Salvaged Tubes to Almost Any Circuit

FACED with a new circuit he wishes to build and a collection of salvaged tubes, the electronic experimenter may find it hard to decide which will serve his purpose. Tube manuals are full of information, but after studying the bewildering array of tubes listed in them, the beginner may find himself as badly off as before. The way out of this confusion is to understand the six basic tube types. It will be simple then to classify the tubes on hand and make full use of the data in the manuals.

"Triode," "pentode," and "tetrode" are simply general classifications, each covering several subdivisions. These subdivisions are based upon the operating characteristics of the tube and the use for which it is intended. The steady progress of research has constantly added new tubes in each category, yet to keep older equipment in use, it has also been necessary to keep available the older types of tubes. This results in the plenitude we find in the manuals.

Another reason for the large variety of

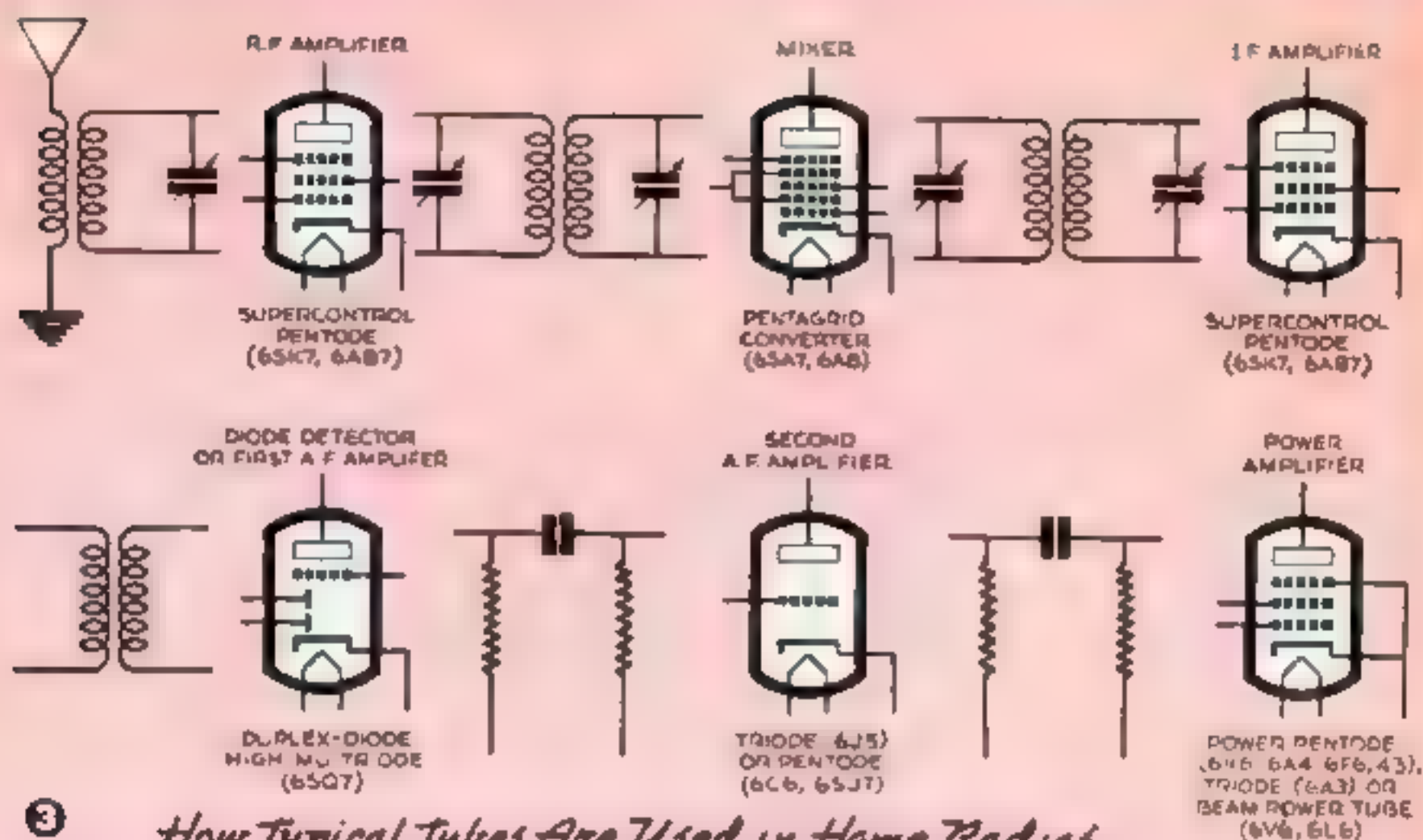
tubes is that different filament-heater voltages are used in various radio receivers, and each of the basic tube types must, therefore, be available in different heater ratings. Thus a 12SK7 and a 6SK7 are identical save for the heater voltage—12 for the former and six for the latter. Portable radio receivers designed to use flashlight cells as a source of heater current also need pentodes such as the 6SK7. The 1T4 was designed for them.

Most standard electron tubes have been designed for use in radio receivers simply because these have offered the greatest market for them. However, radio tubes will serve admirably in many other applications. Most radio and laboratory needs can be met with six basic types: the 6SJ7, 6SK7, 6SA7, 6SQ7, 6J5, and 6L6. Almost any tube listed in the manuals can be understood by comparing it to one or the other of these six basic types.

The 6J5 is a triode. So is the 6SQ7, but this tube has two small detector diodes as well. Frequently these are ignored and the tube is used simply as a high-gain triode. Both are modern tubes. It must not be supposed that because the triode was the first developed it is an inferior tube. It is not an extremely high-gain tube, but for many purposes it is the best choice never-

CAN I USE?

BY JOHN W. CAMPBELL, JR.



theless. The biggest transmitter power tubes—100,000-watt giants—are triodes.

Tube manuals list two kinds of triodes—voltage amplifiers and power amplifiers. Each of these is in turn subdivided into two classes—the voltage amplifiers as medium-mu and high-mu, and power tubes as low-mu and high-mu, mu standing for the amplification factor. The designation of voltage or power amplifier indicates what kind of gain the tube provides. Each has advantages in certain applications.

One type of gain does not exclude the other; a voltage amplifier steps up the power (current) to some extent, and a high-mu power amplifier amplifies the voltage swing somewhat, but the order of amplification is very different for the two types. For example, a 6A3 power-amplifier triode can deliver as much as 200 milliamperes, while the 6SQ7 voltage-amplifier triode is rated at 0.9 milliampere. The 6A3, a low-gain power tube, passes much more current than a high-mu power tube, while the 6SQ7 is a high-mu voltage amplifier that sacrifices current gain. Between these there is the 6J5, a medium-mu triode rated at 9 milliamperes and capable of an amplification of about 20 times.

In general, power-amplifier tubes require a fairly strong grid signal, but they deliver

a powerful punch at the output. A low-mu triode power tube may require a grid variation of 80 volts and have a plate-voltage swing of only 100 volts, so that its voltage amplification is small. But the current, which on the grid may be less than .01 milliampere, may be stepped up several thousand times at the output.

High-mu power tubes such as the 6AC5 require smaller grid voltages, but they give less power gain. High-gain voltage-amplifier tubes, on the other hand, may deliver up to 100 times as much voltage as is impressed on their grids, but with small current output.

The distinction between voltage and power amplifiers holds for tetrodes and pentodes as well as for triodes. However, the tetrode power amplifier becomes the beam power tube, which in effect acts as a pentode. Pentode and beam power amplifiers require much smaller grid voltages than do triodes; their great gain makes them more efficient for small apparatus such as radio receivers and public address systems. Two 6L6 beam power tubes can supply 15 to 30 watts of audio power, or, in a special hookup, as much as 80 watts—enough to be heard two miles away. Amateur short-wave transmitters using two 6L6's can communicate across the continent. The 6V6 is a slightly

smaller beam power tube that can be used in the same way.

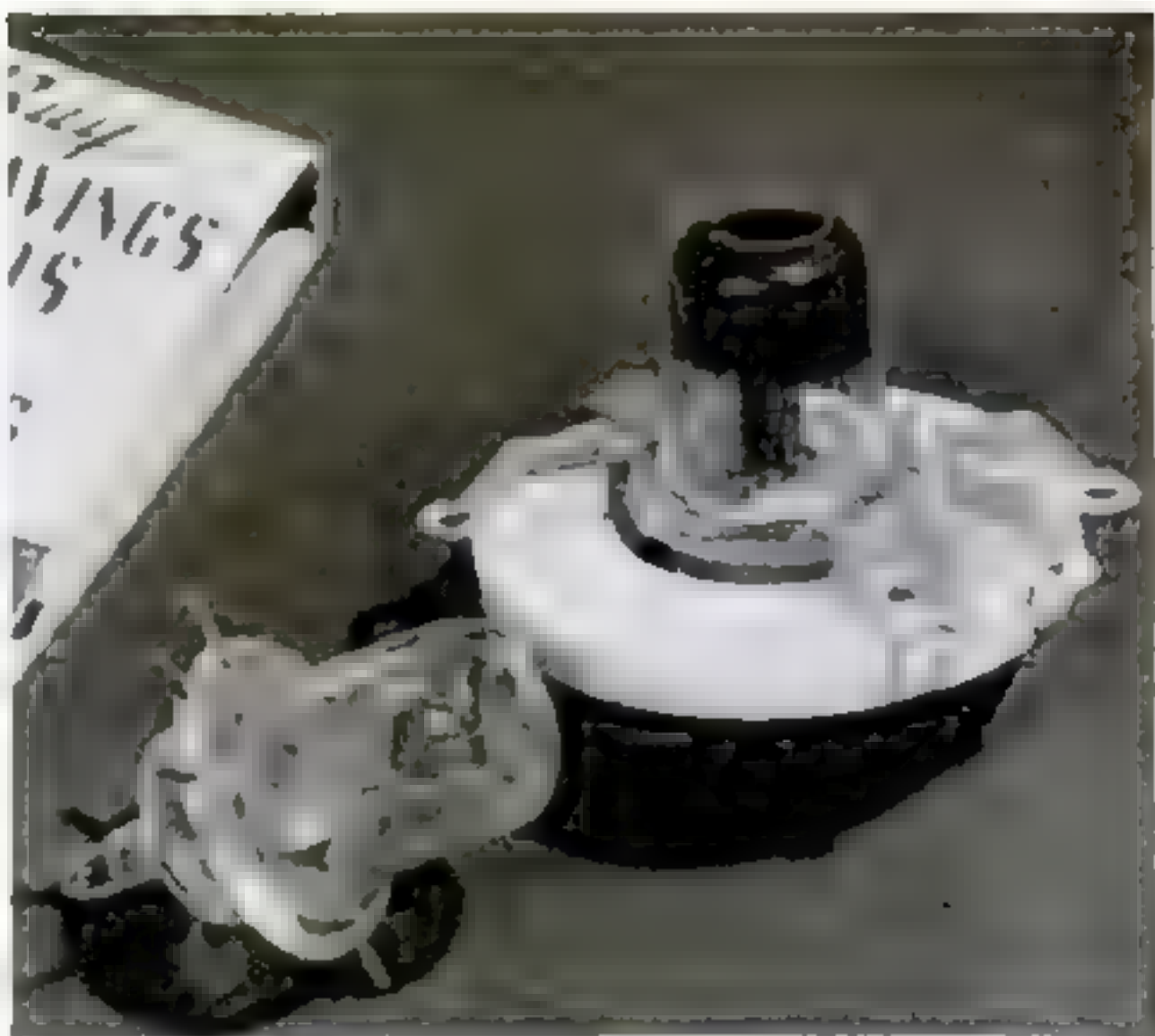
Tetrode and pentode voltage amplifiers are divided into remote-cutoff and sharp-cutoff types, the latter also being called a variable-mu or supercontrol pentode. The difference between these lies in the structure of the control grid.

So far as electrons are concerned, the grid wires can be "inflated" by impressing on them a negative potential until, in effect, they overlap and block the tube. Closely spaced grid wires will be so inflated when a charge of only a few volts is applied. Widely spaced wires will be individually inflated as much with the same charge, but because of their greater separation, they will not block the tube.

Two pentodes among the six basic tube types illustrate this. In the 6SJ7, the control-grid wires are closely and uniformly spaced (Fig. 1). With a negative charge of 3 volts on the grid, a change of 1 volt will cause a change in plate current of 2.5 milliamperes. In the 6SK7, the change in plate current would be about 2 milliamperes under the same conditions, and both tubes would have about the same amplification.

The 6SK7 has grid wires that are not uniformly spaced. As shown in Fig. 2, those at the top and bottom are spaced like the grid wires of the 6SJ7, and at a potential of -3 volts they act in much the same way. But the entire grid of the 6SJ7 "overlaps" at -9 volts; the tube is blocked and stops conducting at that point, whereas the 6SK7 is still strongly conductive at a grid charge of -19 or even -29 volts, because its grid wires are widely spaced in the middle. This wide spacing permits the tube to pass current, but it also makes it less responsive to changes in grid potential. For example, with a charge of -35 volts on the grid, a 1-volt signal will alter the plate current by only .01 milliamperes. Thus, at high grid potentials, amplification is very low.

This feature characterizing the supercontrol pentode is very useful. With ordinary tubes, volume control is gained only by varying the strength of the signal impressed on the grid with a potentiometer or a similar device. With supercontrol pentodes such as the 6SK7, the entire signal can be fed into the grid, and amplification control can be gained simply by varying the grid



Shown full size, these tiny ocm triodes work at 500,000,000 cycles and more. In the socket is a 6-volt tube; the other is a 1 1/2-volt type

bias. This is purely an electronic control, involving no mechanical parts, and therefore it can be readily incorporated into an electronic circuit. It is this automatic volume control that permits you to tune from a near-by 50,000-watt station to a 5,000-watt one in another city without touching the manual volume control.

The 6SK7 differs from the 6K7 chiefly in being provided with internal shielding and having the control-grid lead come to a prong in the base instead of to a grid cap.

Sharp-cutoff pentodes like the 6SJ7 and 6J7 are used in high-gain audio amplifiers, detectors, oscillators, and D.C. amplifiers. Frequently they are hooked up as triodes.

Heater rating is indicated by the figure preceding the letter or letters in a tube designation. For each heater voltage there is, in general, a high-gain pentode like the 6J7, a supercontrol pentode corresponding to the 6K7, a pentagrid converter similar to the 6SA7 or 6A8, a general-purpose triode like the 6J5, a high-mu triode such as the 6F5, and a duplex-diode high-mu triode equivalent to the 6SQ7. There will also be power-amplifier triodes corresponding to the 6A3 or 6AC5.

If a circuit diagram calls for a 6SJ7, a little adjustment of resistance and condenser values will permit you to use a 6J7, a 6AC7, a 6C6, a 12J7, or any of several other pentodes. A few 6-volt tubes, however, and some of the battery-type pentodes, have the suppressor grid con-

connected to the cathode within the tube. Usually 6SJ7 circuits call for this connection anyway; if the one in question does not, internally-connected pentodes can't be used.

Both pentodes and tetrodes can be used as triodes. Simply connect the extra grid or grids to the plate. Some tube handbooks include data for using pentodes in triode connection in resistance-coupled amplifiers.

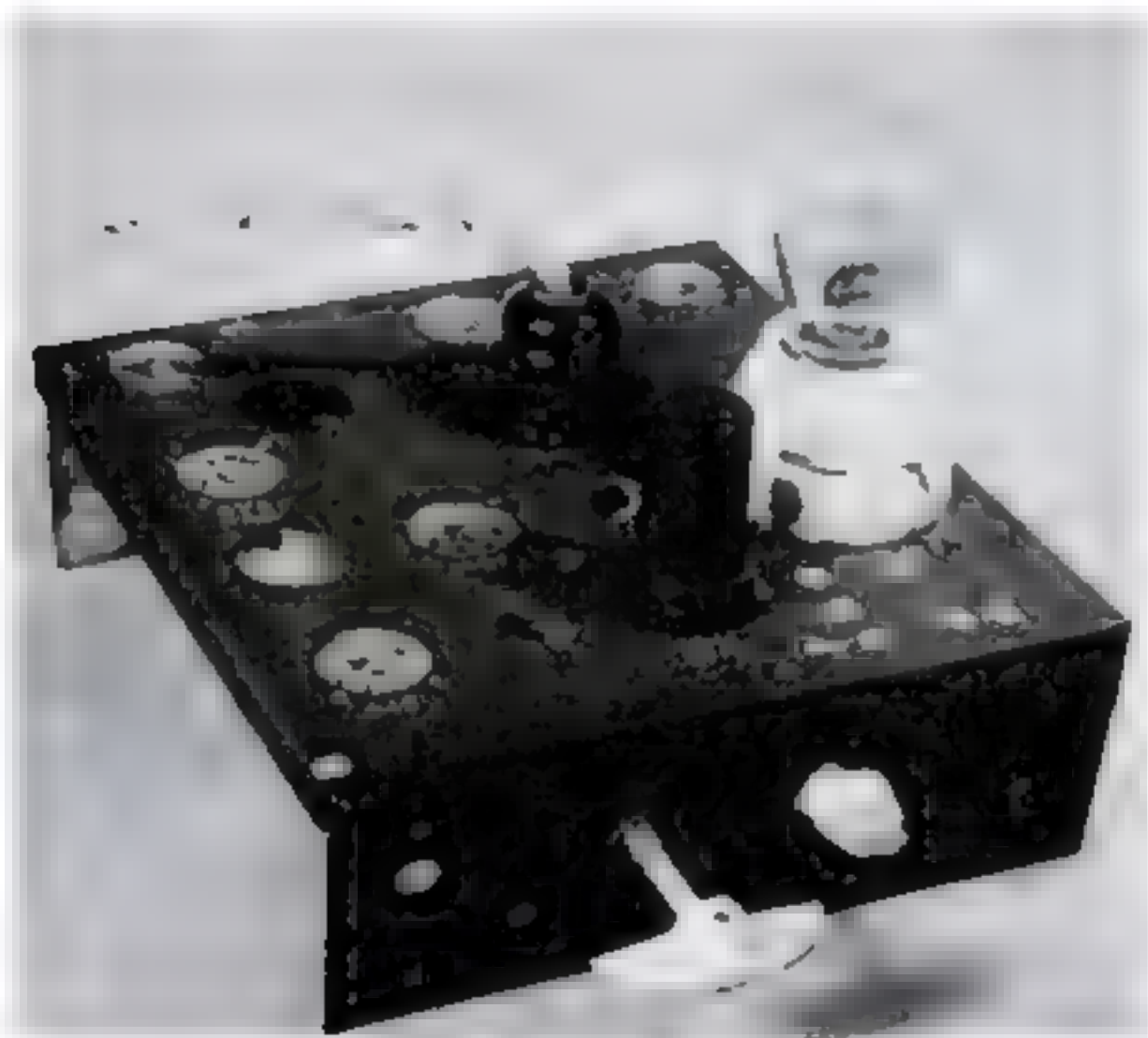
Among the things you cannot do is to use a voltage amplifier (6SJ7) to replace a

power amplifier like the 6K6, or vice versa.

The suffix "G" or "GT" indicates the tube type designated in a glass envelope instead of a metal one, the tube being otherwise identical.

With the advent of multielectrode tubes, the four-prong socket gave way to others until today the octal (eight-prong) socket is standard. It is wired differently for various tubes. Diagrams always show socket connections as seen from beneath the chassis.

Glow Lamp Demonstrates Cutoff Action of Various Tubes



Extra sockets can be added. This chassis has one for testing 6SQ7's

WITH this simple test circuit, you can compare visually the plate current that is passed by different tubes at various grid potentials, and you can also demonstrate the cutoff action of the tubes. An argon glow lamp will serve satisfactorily as the indicator in the circuit. It is sensitive to a current as small as .01 milliamperes, and gives a visible indication of changes in current from this value all the way up to 50 milliamperes.

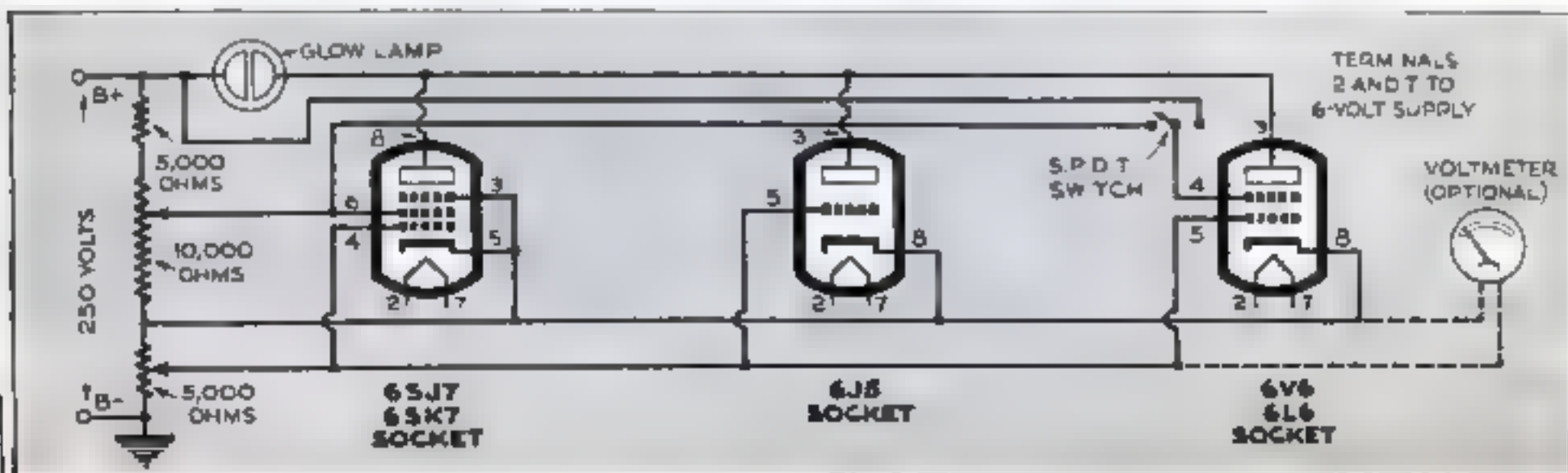
beam power tubes frequently operate at full plate-supply voltage, being connected directly to the plus side while the plate is connected through the load. The switch shown permits this hookup.

A voltmeter is optional. It will show exactly what grid bias is being applied. A milliammeter, if available, may be used in place of the argon bulb for better comparison of the plate current passed.—J. W. C.

Between .01 and .1 milliampere, the character of the glow changes; from .1 to 5 milliamperes the area of glow increases; and above 5 milliamperes the brilliance of the glow in-

The circuit can be assembled on an old radio chassis. Three sockets are used to facilitate the testing of different tubes. If available, old sockets will do satisfactorily, or three octal sockets can be utilized by wiring them as shown, the unused terminals being disregarded.

One 5,000-ohm fixed resistor and two potentiometers are required. The 5,000-ohm potentiometer makes it possible to vary the control-grid voltage, while the other permits variation of the screen-grid voltage. The screens of



LOUDSPEAKER ADJUSTMENTS

Servicing Your Radio

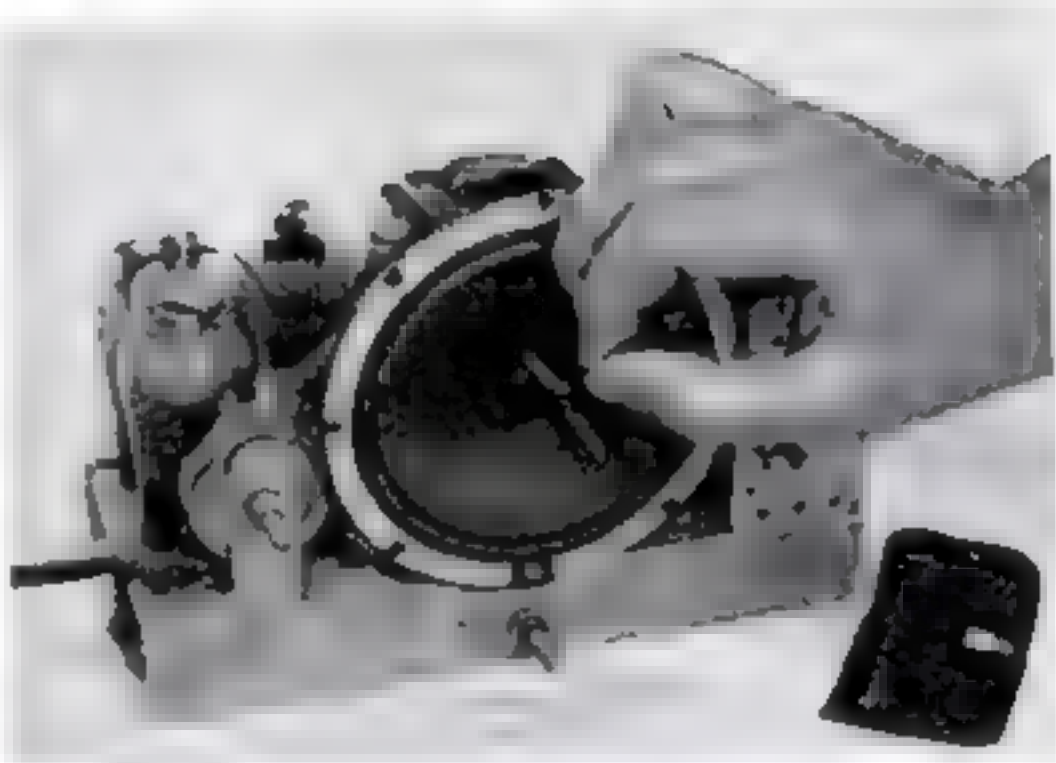
MANY radio owners will put up with a certain amount of distortion in their loudspeakers rather than tackle a repair because they realize how delicate such work is. Loudspeakers have air gaps of only .005". If care is exercised, however, a competent serviceman or home mechanic should be able to do an effective job.

The most common fault is an off-center cone. This usually causes a fuzziness in the reproduction, especially when the volume is turned low. To recenter the cone, obtain colored-paper shims at a radio store, or cut shims from stiff paper such as that used for calling cards.

Three strips are required for proper centering, and they are placed at 120-deg. angles from each other in the center of the cone, as shown in the photograph at top. The cone is loosened slightly to receive them by means of its centering screw and then is retightened.

This centering screw is usually behind the speaker magnet or in front in the middle of the cone; but if the speaker has no such screw, the whole cone and voice-coil assembly can be loosened by applying a cement solvent or lacquer thinner to the cement holding the rim of the cone to the frame of the speaker, as in one of the photos. Use the three shims the same way, and then cement the cone back to the speaker frame and let it dry thoroughly.

Many loudspeakers have a "papery" sound that mars the reproduction. This is sometimes caused by an off-center cone, but more often it is due to an open seam in a cone that has not been pressed or molded from a single piece. Cement in the seam dries out after a time, and the loose edges touch while the cone is vibrating, thus causing the objectionable sound. This trouble can be remedied easily by putting new cement in the open places along the seam. Tears in a cone may be similarly cemented, as shown in the bottom photograph.



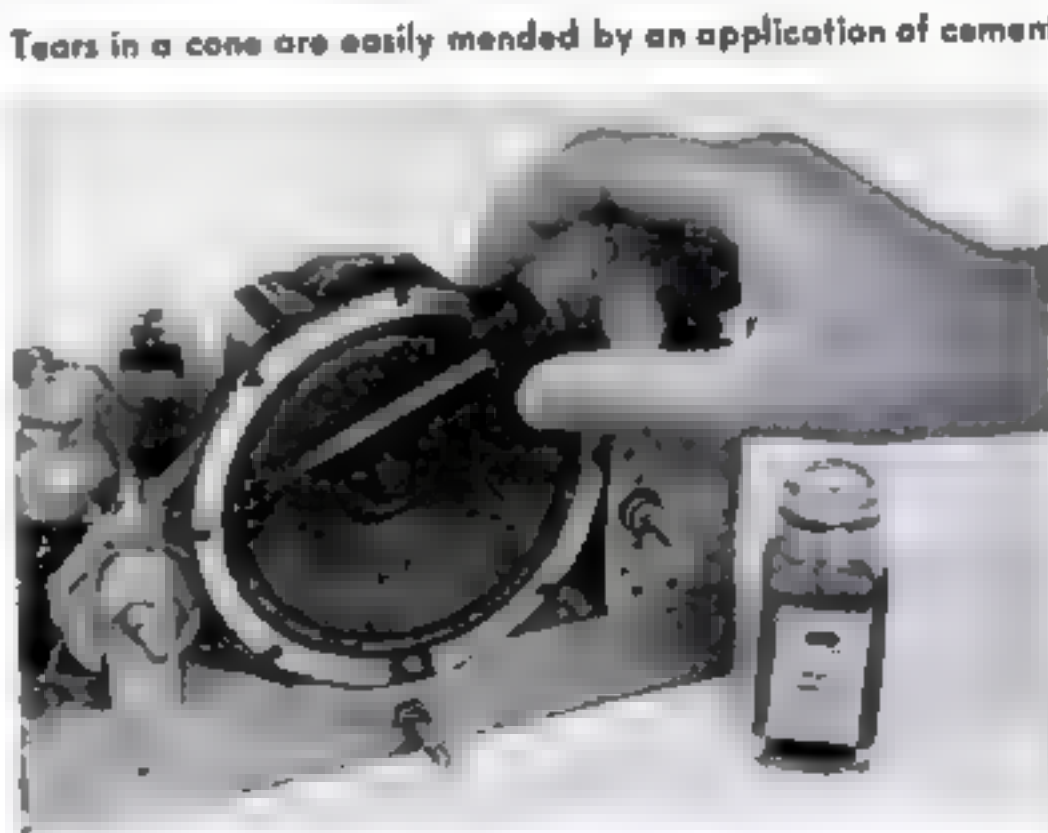
Three paper shims are inserted to center a loudspeaker cone



Loosen the cement at the rim of the frame to remove a cone that has no centering screw



Paper centering shims of different thicknesses can be obtained in a small kit



Tears in a cone are easily mended by an application of cement

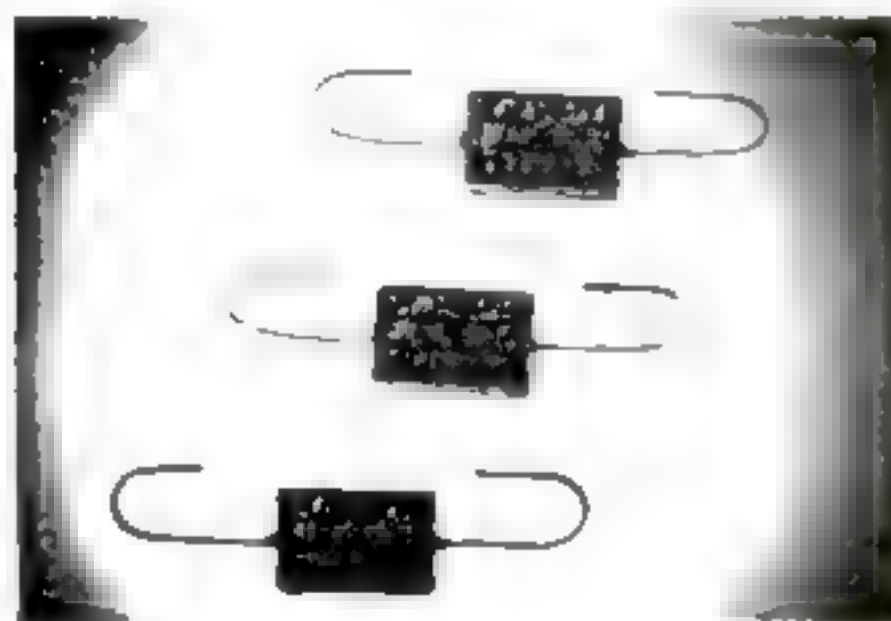
radio ideas



Both a headset and handset are used with the F.M. walkie-talkie so two can listen in. There are also two types of antennas



LINE-CORD RESISTORS can be replaced by standard plug-in ballast tubes with the use of a new resistance-cord adapter now on the market. The adapter, shown below, is mounted either inside or outside the cabinet, and its leads, color-coded the same as those of the old cord, are soldered to the connections of those being removed. A ballast tube of the proper voltage drop is then plugged in. Four types of adapters will replace all the resistance power cords now in use.



MIDGET PAPER CONDENSERS now come in a new and smaller size for use with modern compact battery equipment or in other circuits where D.C. does not exceed 120 volts. These tiny condensers, shown about half size above, are available in the customary capacities up to .01 mmfd. They are made of paper and aluminum foil, impregnated with transformer oil, then molded in a casing, normalized, heat treated, and vacuum-impregnated at high temperature.

PENCIL GRAPHITE

... FORMS
RESISTANCE
ELEMENT FOR
THIS INGENUOUS
RHEOSTAT



A thick coat of graphite is rubbed on the tube with a soft pencil

GRAPHITE from a soft lead pencil rubbed onto a common porcelain insulating tube is employed in making an ingenious little rheostat that will control the speed of a small motor or the brightness of a photographic-enlarger lamp of not over 100 watts current draw. The tube is of the type used for many years in carrying house wiring through joists and studs. An ordinary lead pencil will serve, but it should be soft so that it will deposit a heavy coating.

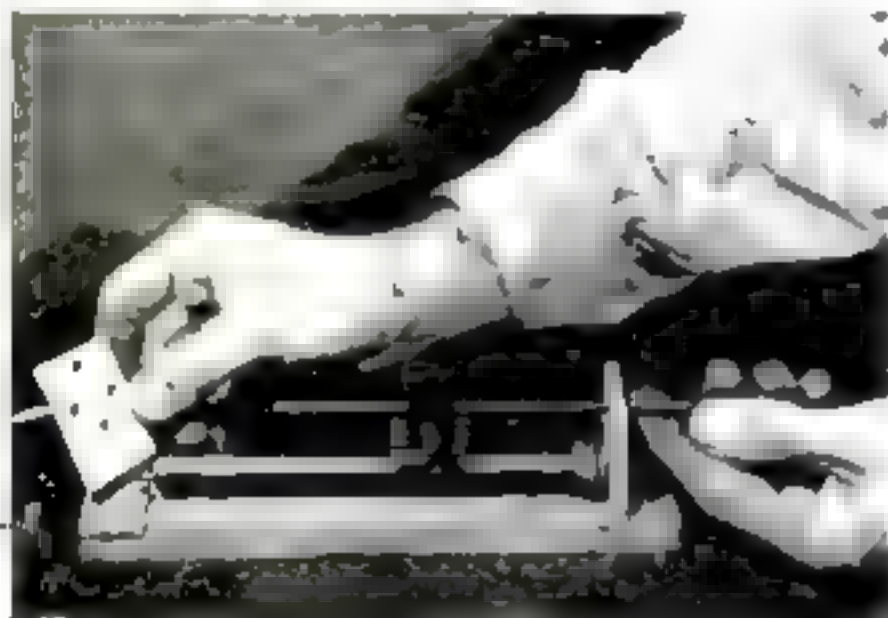
Blacken the outside of the tube completely; then bend a $\frac{1}{2}$ " wide strip of copper to form a contact clamp. Shape a sliding contact of spring brass to fit around the tube and touch a considerable area of the graphited surface. Cut two $1\frac{1}{2}$ " by 2" end plates from $\frac{1}{8}$ " asbestos board and drill them to re-

ceive two $\frac{1}{8}$ " to $\frac{1}{4}$ " rods threaded for nuts at both ends. One rod extends through the tube, and the other runs parallel $\frac{3}{8}$ " above it. Cut, slot, and drill a piece of plastic insulator to straddle the sliding contact, and slip it on the upper rod, as shown.

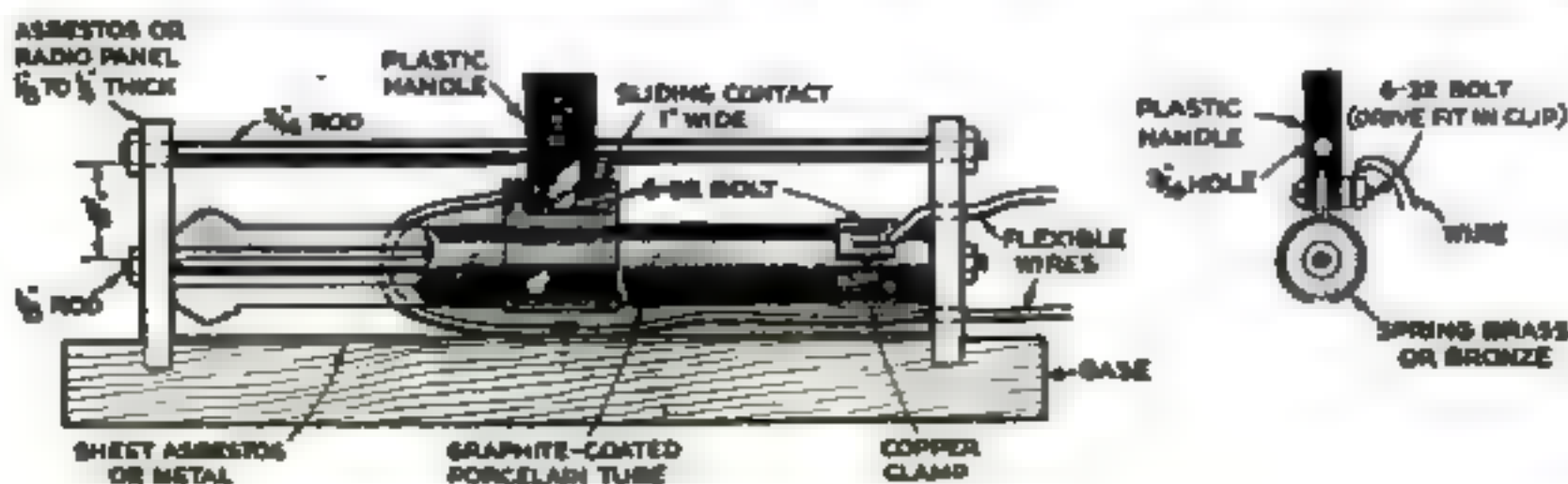
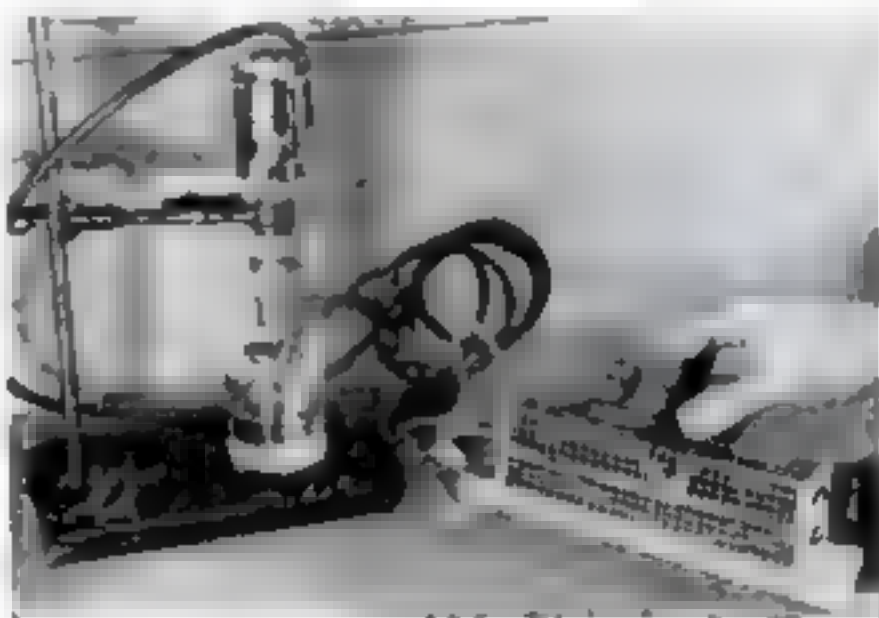
Connect wires to the sliding contact and to the fixed clamp on the tube, and run them through holes drilled in one of the end-pieces. Shield the base from heat with a sheet of asbestos paper, and enclose the rheostat in $\frac{1}{4}$ " wire mesh, leaving a $\frac{3}{4}$ " slot at the top for the handle of the slide.

The rheostat should give consistent service for a long period. If the graphite should wear off, it can be renewed, and any deposit from the sliding contact can be removed with a wire brush.—WALTER E. BURTON.

Two slim rods tie the end plates into the device



Here the completed rheostat controls a small motor

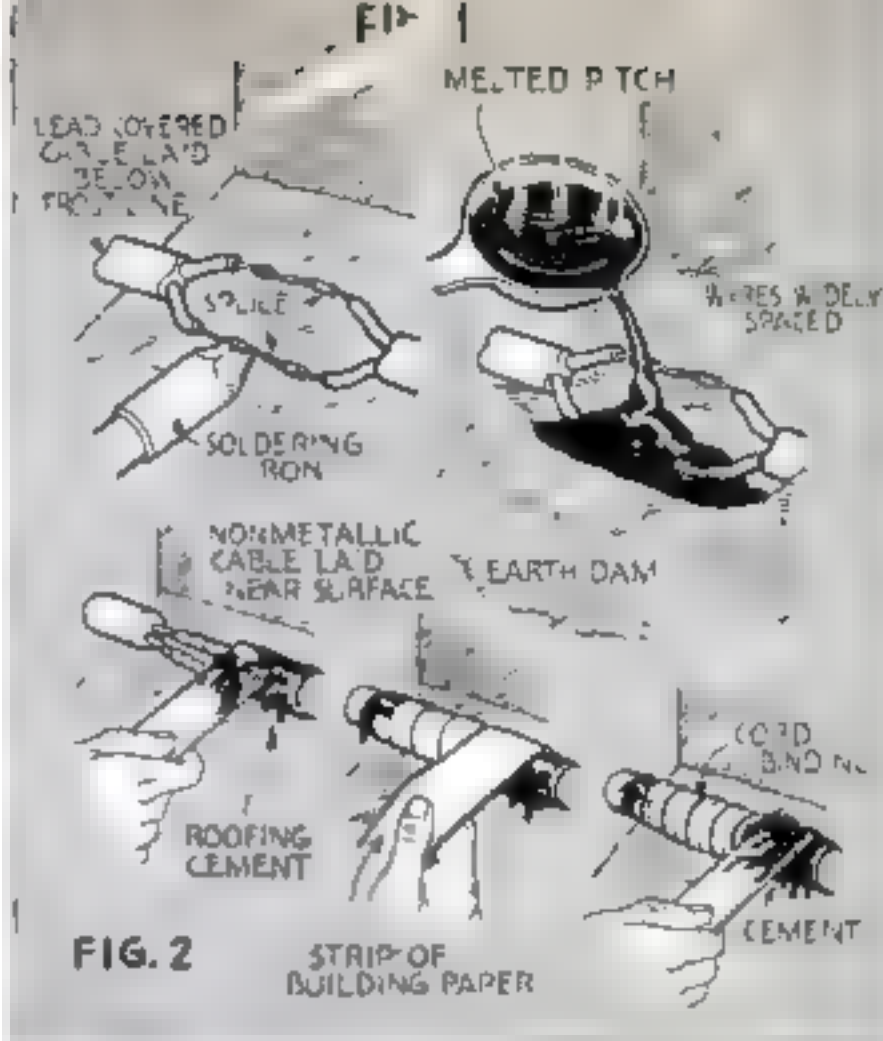


Two Quick Permanent Repairs of Buried Electric Cables

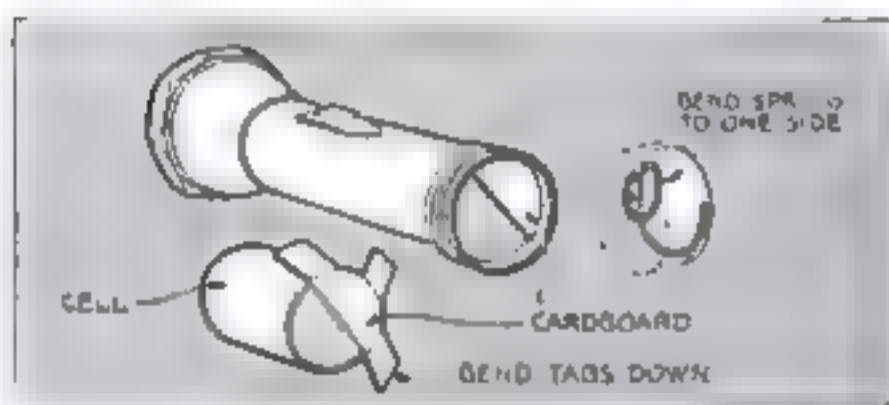
DAMAGED underground electric cables can be repaired with the help of a few commonplace materials. Always be sure first to disconnect the line; then cut away the protective coating of the cable about 2" on each side of the break, scrape the bared sections of the wires clean, and splice them, if they are broken, as shown in the drawing. Solder the splices to insure good contact.

Some form of rot-resisting insulation—a rigid type if the cable lies deep in the ground where it will not be disturbed by the movement of frost or other pressures—must be used to cover the bare wires. Melted pitch will serve the purpose if poured into a mold made by mounding up earth around the splice, as illustrated. The pitch should be allowed to set hard before the trench is filled in.

Flexible insulation must be employed if the cable is subject to possible disturbance from above. For such a job, the spliced wires should be wound with both rubber and friction tape, and then covered with enough roofing cement to fill in and cover the entire joint. Building paper should next be wrapped



around the joint, bound securely with wire or a strong cord, and given a final coating of cement. If well made, a splice of this kind can be covered with earth or submerged in water even directly after it is finished.—J. M.

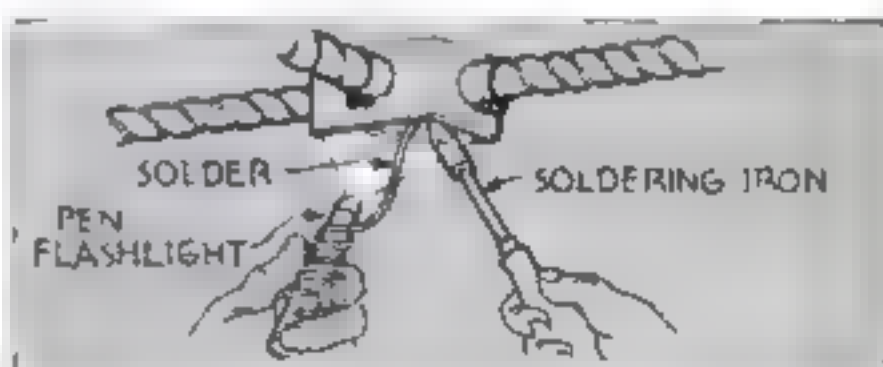


Substitute Flashlight Switch

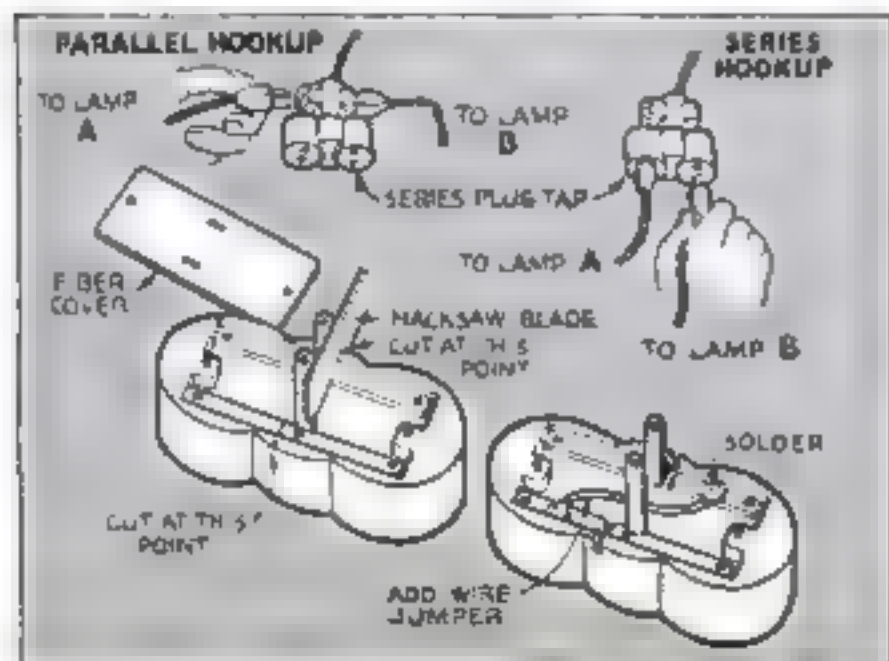
WHEN the switch of a flashlight breaks down, a new one can be improvised, as at the left, by bending the cap spring to one side and covering half the bottom of the rear cell with cardboard. A twist of the cap turns on the light.—RALPH S. WILKES.

Soldering Aid for Dark Places

TO ILLUMINATE a soldering job in a dark outlet box or radio cabinet, wrap the solder around a thin-barreled flashlight, as shown below. Let one end extend far enough to have a sufficient working length. This gives light at the very tip of the iron.



Altered Duplex Outlet Plug Replaces Series-Parallel Switch



CHANGED as shown in the drawing, a common duplex plug can be employed in a combination that will take the place of a series-parallel switch, such as is used with photographic lamps. Remove the cover from the plug and cut apart both of the connecting straps, making two cuts close together to achieve ample separation. Then solder on a wire jumper, using wire heavy enough to carry a substantial load. To change hookups, simply shift the lamp plugs, as illustrated.

EXPERIMENT WITH SOUNDS

RESONANCE OCCURS when one body vibrating at a certain period, or frequency, causes the sympathetic vibration of another body tuned to the same frequency. For example, certain piano tones often cause nearby objects having the same natural frequency to rattle. This can be demonstrated electrically by stretching an 18" iron wire across two wooden blocks with a turnbuckle between one block and the anchoring point. Near the middle of the wire mount an iron bolt wound with several hundred turns of

bell wire. Connect this improvised magnet in series with a heating unit and a 110-volt A.C. line. Tighten or loosen the stretched wire by turning the buckle. At all degrees of tension, save one, the wire will remain silent and stationary. But at one point it will vibrate violently, indicating that it is in tune, or in resonance, with the 60-cycle alternations of the current. The A.C. pulsations, being of the same frequency as the period of vibration of the wire at this tension, cause the wire to vibrate with them.

A LOCOMOTIVE WHISTLE seems of higher pitch when the engine is approaching than when it is going away. Known as Doppler's principle, this phenomenon is due to the fact that more than the normal number of sound

vibrations reach your ears per second when a train is coming toward you, and fewer when it is speeding in the other direction. Sound wave fronts are normally spaced when the train stands still, but when it moves,

they are crowded together in front of the whistle and stretched apart behind it. With a toy whistle fitted into a length of rubber tubing, you can demonstrate how the motion of a sonorous body will affect the way it sounds. First, blow through the free end of the tube to determine the normal pitch of the whistle. Then, if you whirl the dangling end of the tube while still blowing into it, you will find that the pitch of the whistle will oscillate, rising and falling to a greater degree the faster you whirl the tube. A shower hose about 4' long will serve for the test.

POPULAR SCIENCE

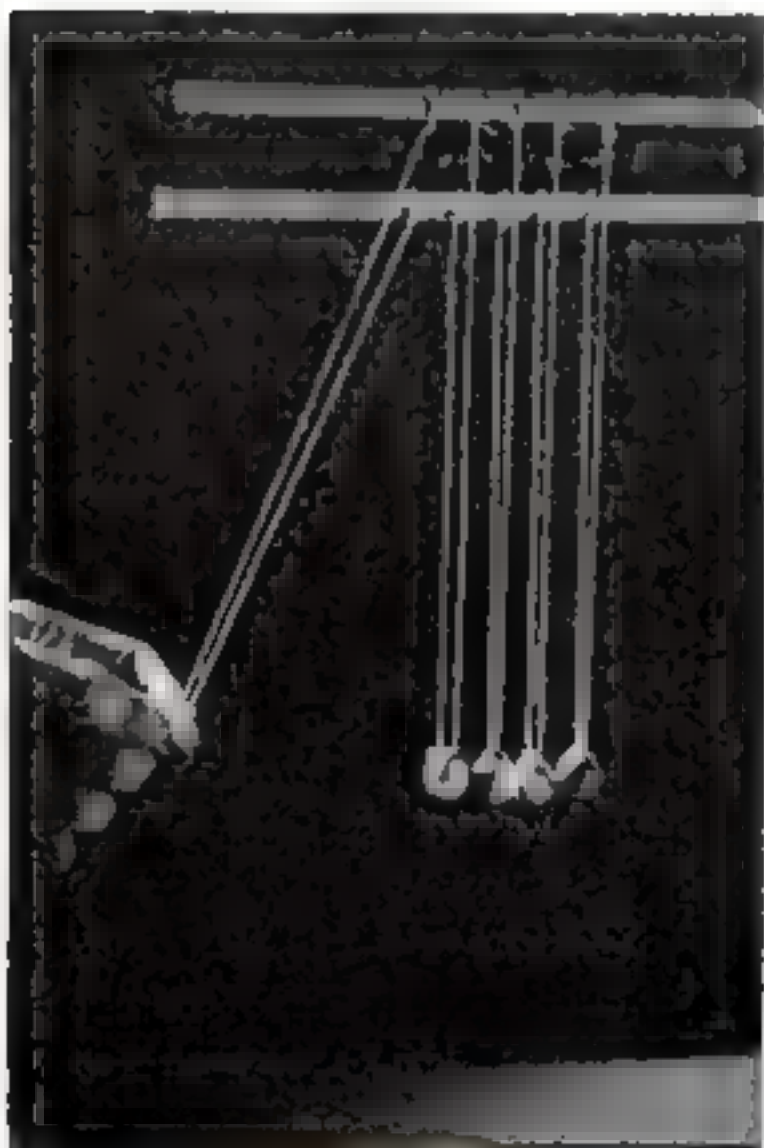
"PIPES OF PAN," on which you can play as tunefully as any satyr, can be built out of a strip of corrugated cardboard and eight paper or cellulose soda straws to form a complete octave. This improvised instrument will duplicate essentially the operation of a pipe organ and of various other standard wind instruments. Just push the straws through every second hole in the corrugated strip. Since the pitch of these tubes will be governed by their length, tune them by ear by clipping off the ends of successive straws until each one has acquired the desired pitch. The longest straw will give the lowest note, at *do*. Upper *do* at the other end of the scale will be produced by a straw half the length of the one that sounds the lowest note, and the intermediate notes will be obtained from straws of even gradations in length. All you have to do to play these pipes, which are sometimes referred to as a "syrinx," is to hold the tops of the straws close to the lips and blow across them.



SOUND IS TRANSMITTED by means of waves of alternate compressions and rarefactions of the air or other medium through which it travels. The medium itself does not travel with the sound, but merely passes the energy of the sound wave from particle to particle. How these waves travel, without

the medium going along with them, can be demonstrated by the simple setup shown in the photographs below. Five marbles are suspended so that each just touches the next as they dangle from strings about a foot long. If each marble is supported by two strings hung from two parallel rods that are

separated from each other by several inches, as in the illustration at left, they will not tend to swing sideways—a motion that might lessen the force of the impulse to be communicated through them. After arranging the marbles in a straight line, pull back the first one and let it swing against the next. The force of this impact will not disturb the marbles in the middle of the line perceptibly, but it will cause the one at the opposite end to swing away from the perpendicular. Thus, through the forces of compression and expansion, energy will be transmitted through the middle marbles—much like sound through air—without moving them to an appreciable extent.



Ammonia

This versatile, water-soluble gas is vital in producing explosives, fire extinguishers, medicine, and a variety of household cleansers

By KENNETH M. SWEZEY

KNOWLEDGE of ammonia and ammonium compounds dates back far beyond the beginning of chemistry, or even alchemy. Doubtless the cave man was familiar with the pungent odor of ammonia as generated by decomposing plant and animal life. Pliny wrote of sal ammoniac nearly 2,000 years ago. Alchemists distilled the strong-smelling chemical from horns, hoofs, and other animal refuse. Since they felt that the best product was obtained by distilling deer antlers, they called ammonia water "Spirits of Hartshorn."

Ammonia is a gas—a simple compound of nitrogen and hydrogen, the formula of which is NH_3 . Today, vast quantities are made by heating a mixture of hydrogen and nitrogen under great pressure in the presence

of a catalyst. A considerable amount is also obtained as a by-product of the coke and illuminating-gas industry by processes resembling those used by the alchemists of old. These processes are based on the fact that when bituminous coal is heated without access to air much of the nitrogen it contains combines with hydrogen to form ammonia.

When ammonia is dissolved in water and neutralized with acids, it forms ammonium compounds. Hundreds of tons of ammonia are used annually as a basic material in the manufacture of important military and civilian products. It is a primary reagent in the making of nitric acid (vital in producing nitroglycerin, TNT, and other explosives) and in the preparation of numerous other ammonium compounds needed in medicines, fertilizers, cleansers, fireproofing, photography, and chemical analysis.

You can duplicate the methods of the alchemists by heating a little hair or fingernail parings

Ammonia is generated and the gas is collected by displacement when NH_4Cl mixed with a common base such as slaked lime is heated, as shown below



mixed with slaked lime in a test tube. Ammonia will distill off immediately, for organic matter like hair and bone contain ammonium compounds which yield ammonia upon disintegration.

The easiest way to generate ammonia for experiments is to heat ammonium sulphate, or ammonium chloride, mixed with slaked lime. Heat decomposes the compound into ammonia and its constituent acid, while the lime neutralizes the acid and prevents its recombination with the ammonia.

Mix two parts of the powdered lime with one part of the ammonium salt. Place the mixture in a large test tube and clamp the tube horizontally with its mouth tilted slightly downward. Since ammonia gas is little more than half as heavy as air, it will rise and displace the latter. Thus you can readily collect ammonia in an inverted jar or larger tube arranged to collect fumes from the test tube, as shown by the setup on the facing page. Warm the mixture in the test tube with a small flame kept moving constantly. Ammonia will soon rise into the collecting vessel. You can tell when this vessel is filled by holding beneath its opening a glass rod with a drop of hydrochloric acid on the tip. White fumes will indicate that the vessel is overflowing with gas. Trap the ammonia by sliding a glass plate smeared with petroleum jelly across the mouth of the inverted receptacle.

Ammonia is extremely soluble in water. At room temperature, one volume of water will dissolve 700 volumes of the gas, while at the freezing point water will hold about 1,300 times its own volume of it. If you invert your vessel of ammonia in a pan of water, the water will rise in the vessel as the gas is dissolved by it.

Though common to every home, ammonia water is a complex substance worth investi-

Heat is not always necessary to generate ammonia. A small pile of ammonium chloride and another of calcium hydroxide are held in the hand (below). If you rub the two together, ammonia can be smelled

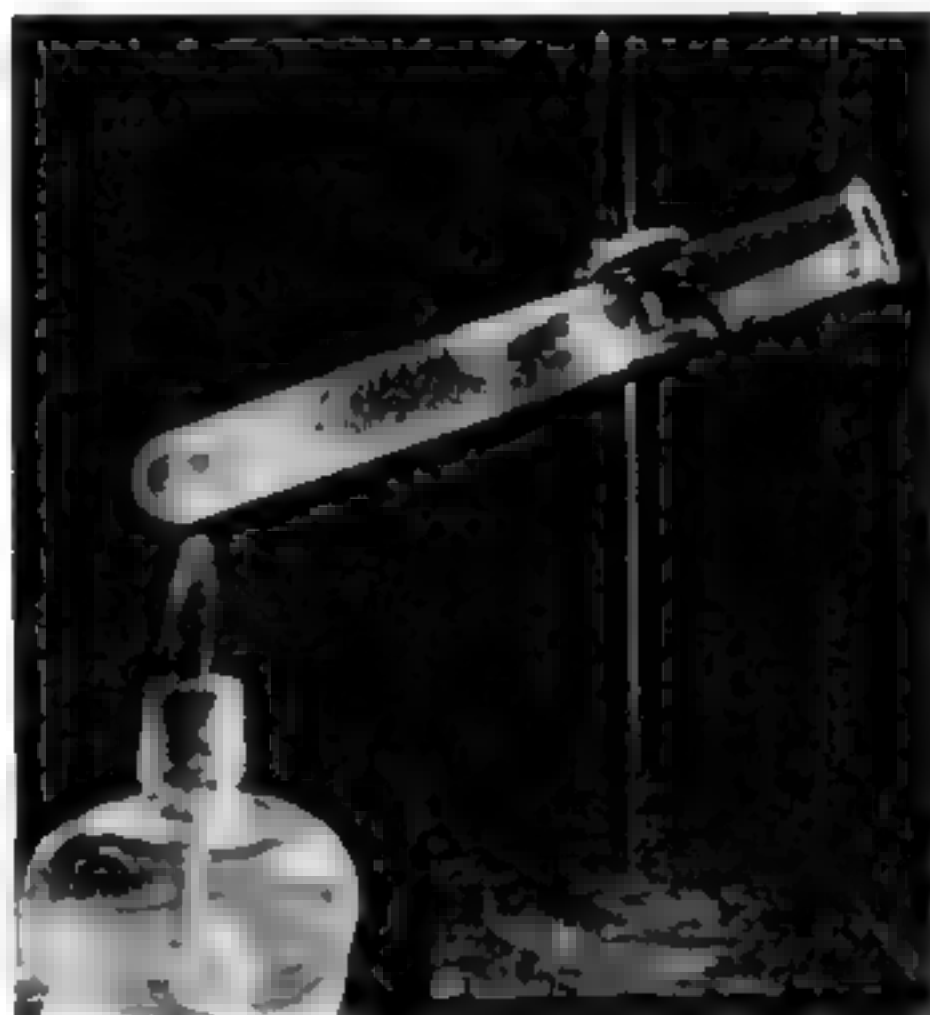


Solubility of ammonia is shown as water rises in the gas-filled test tube inverted over a bowl, as at top. The complexity of ammonia water can be revealed by adding an indicating agent to a cold solution, turning it pink. Color will vanish as the NH_4OH is heated, reappearing as it cools



Ammonium bicarbonate, when warmed in a flask as shown at the left, will liberate enough carbon dioxide to smother a match flame. This quality makes NH_4HCO_3 valuable as a fire extinguisher.

That ammonia is a penetrative gas can be shown, as below, by heating NH_4Cl and testing the freed gases as they seep through a barrier of asbestos.



gating. Although about two thirds of this solute is ammonia gas in physical solution, the remainder is a new compound formed by the real chemical combination of ammonia and water molecules. In this combination one hydrogen ion from the water joins with the ammonia, thus: $\text{NH}_3 + \text{H}^+ + \text{OH}^- = \text{NH}_4^+ + \text{OH}^- = \text{NH}_4\text{OH}$. The latter is the weak base, ammonium hydroxide. It is the hydroxyl ion in this hydroxide compound, and not merely dissolved ammonia, that causes ammonia water to react as an alkali.

Transformations that can take place in ammonia water can be demonstrated by a simple test. Put two or three drops of concentrated ammonia water in 200 ml. of cold water in a beaker, and add ten drops of phenolphthalein solution. The resulting solution is a brilliant pink. If you now bring the solution to a boil, the pink color will almost disappear. Has the ammonia been boiled from the water? A little may have been, but the real reason is that, when hot, the ammonium ions are largely decomposed into water and ammonia gas, leaving insufficient basic ions to affect the indicator. When the water cools, the water and the ammonia will again form ammonium hydroxide, and the pink color will reappear.

Dry ammonia gas is almost completely inactive chemically. Add a trace of water, however, and it combines readily with acids to form compounds. Ammonium differs from ammonia in that it has an extra atom of hydrogen. Ammonia is a gas which can exist by itself, but ammonium is the radical which cannot exist alone.

To test for any ammonium compound, heat the suspected substance with an active base, such as calcium or sodium hydroxide. The odor is your clue. By mixing ammonium chloride and slaked lime, you can generate ammonia without heating.

Ammonium chloride, used in dry and wet batteries, can be utilized to demonstrate decomposition and diffusion. Place a little of this in a hard-glass test tube loosely plugged with a wad of asbestos, and heat vigorously. A moist piece of neutral litmus paper inserted in the mouth of the tube displays a puzzling reaction. When the heating begins, the test paper turns blue, indicating a base. Soon, however, the paper turns red, revealing that the vapors have become acid.

Why this strange about-face? Heating the ammonium chloride decomposes it into its constituents, ammonia and hydrogen chloride, both gases. Ammonia, however, being a much lighter gas, diffuses through the asbestos plug first, reacting as a base with the litmus paper. When the hydrogen chloride finally gets through the plug, it produces an acid reaction with the paper. Unless the entire tube is very hot, you will notice, also, that much of the decomposed salt recombines and deposits itself on the cooler parts of the tube.

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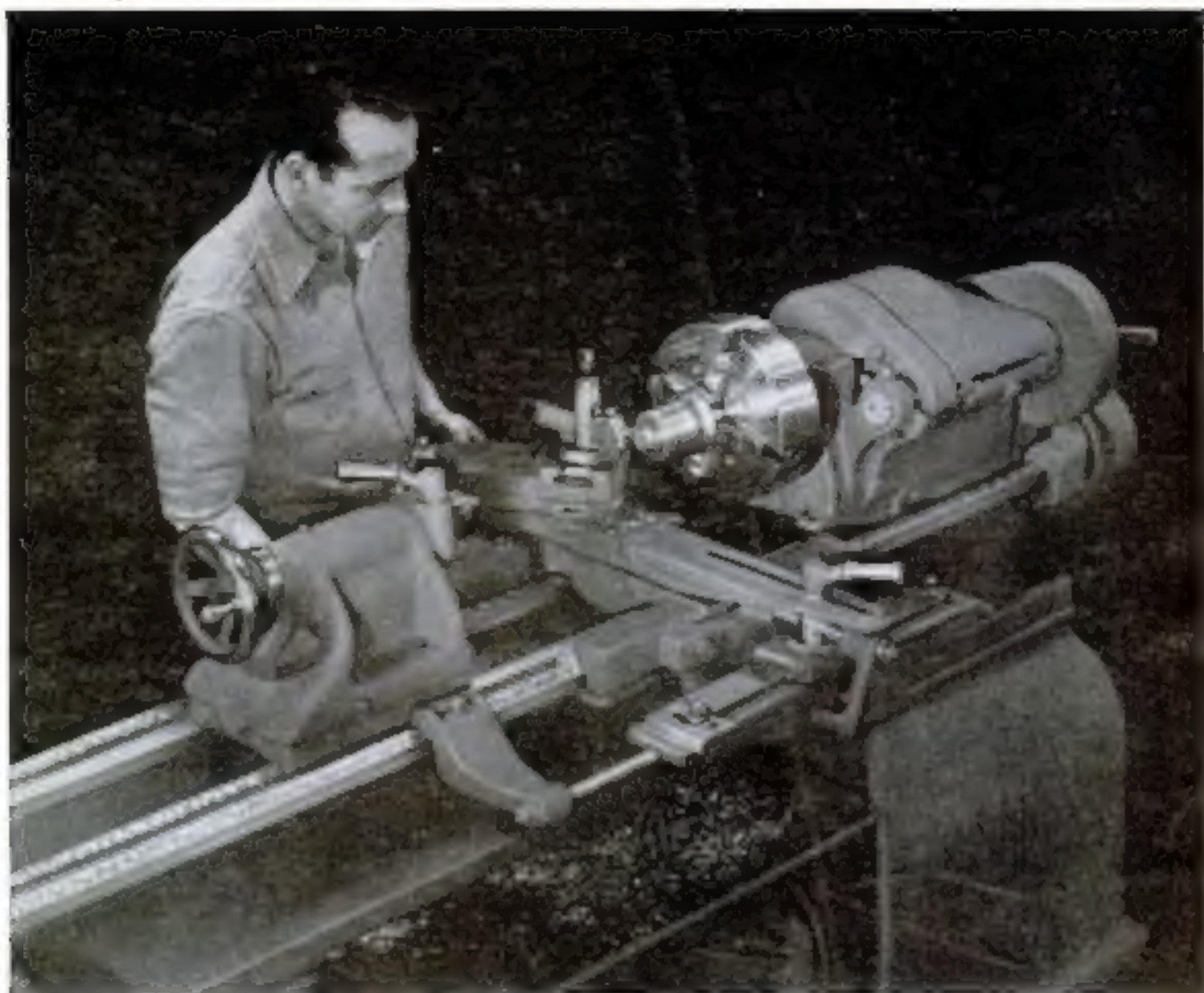
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